THE

ELECTRICAL REVIEW.

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THE

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1900

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ALTERNATING CURRENT INDUCTION MOTORS.

THE subject of alternating current motors is one which has often been treated in our columns. We have often insisted that there was a better fate in store for them than has hitherto been their lot, and our opinion is only strengthened by the paper read by Mr. Eborall on Thursday last week at the Institution of Electrical Engineers. Perhaps the reason why monophase motors have not been a practical success until recently is that manufacturers have not understood the principles upon which they are based.

Even Mr. Eborall's explanation of the principle on which the starting of the Heyland motor is based is somewhat indistinct. As was pointed out by Mr. Rhodes in the discussion, an induction motor is simply a transformer with a revolving secondary coil. Mr. Eborall's statement that the self-induction of the starting coil is less than that of the running coil is very misleading. The statement is only correct when the rotor is taken away, for the starting coil is deliberately wound so as to make its *equivalent* self-induction greater than that of the running coil. The equivalent self-induction of the running coil of a perfect induction motor should be zero, whilst the magnetic flux produced by the starting coil should be at right angles to and equal in magnitude to that produced by the running coil; the starting coil should, in addition, produce a large flux which does not cut the rotor winding at all. For example, to obtain a lag of 60° between the currents in the two coils, the total flux produced by the starting coil should be just double that produced by the running coil, whilst the leakage flux should be 1·732 times the flux produced by the running coil.

By the same process of reasoning the rotor winding should have no equivalent self-induction, because in that case there is no leakage producing a demagnetising action on the stator. The rotor can, however, be left to look after itself since the relation is reciprocal, and if the equivalent self-induction of the stator running coil is zero, so is that of the rotor. In this case the power factor of the motor will be as large as possible after starting, in exactly the same way that the power factor of a well designed transformer is nearly unity when working on load.

Prof. Carus-Wilson pointed out that by the use of condensers it is possible to bring the power factors of induction motors to unity. This is no doubt true, but it is hardly practicable. For a motor taking 100 amperes, and having a power factor of 0·8, the wattless current would be 60 amperes, and to neutralise this by means of condensers would require a capacity of something like 600 microfarads at 100 volts and 100 periods. Now 600 microfarads is, to say the least, rather unwieldy, and would cost more than many motors to build.

As motors are built at present the only way to obtain a high power factor on load, is to make a really good mechanical

job, making the stator and rotor cores absolutely concentric and having only just enough air gap for mechanical clearance. It follows that the bearings must be of the very best. Even then there must be some leakage which will, of course, reduce the power factor. The means adopted by Mr. Rhodes of cutting down the rotor currents at start seems to be capable of producing good results, because if properly applied counter electromotive forces can cut down the wattless currents in the rotor without interfering with the energy current. The point to be noticed is that the wattless currents produce a demagnetising action, and the energy currents produce the torque, so that the proper solution of the starting problem is one which neutralises the rotor wattless currents and leaves the energy currents alone. The insertion of inductive or non-inductive resistance into the rotor circuits cannot do this, and, consequently, cannot produce the best torque for a given supply current.

We are inclined to agree with Mr. Ferranti that the single-phase system will at least hold its own. The starting torque of monophase motors is almost as good as that of polyphase motors, and for transmission purposes the single-phase system is certainly the simplest. If monophase motors are shown to be equal in all respects to polyphase motors, polyphase systems must give way. Some manufacturers have great pecuniary interest in polyphase working, and they will, of course, do all they can to keep it, but in spite of selfish interests the system which is at the same time the simplest and the most effective will eventually prevail.

If those engaged in central station work will devote their attention to the question of regulation, alternating currents will change from a process of retrogression to one of progression. We hear much about changing from alternating to direct current systems, but in the direct current system it is impossible to transmit at sufficiently high potential for all purposes. It is far better to transmit by alternating currents, and use rotary converters, than to generate continuous currents, when long distances are in question. When engineers feel justified in advocating the adoption of alternating motors for traction and other purposes it will not involve great loss to discard the converters. In the meantime, for the sake of ease and economy in changing-over, and on account of the unsuitable character of single-phase currents for use with rotary converters, we adhere to our opinion that the two-phase system is the most generally useful.

The whole issue depends upon the perfecting of the alternating current motor and its adaptability for the various uses to which motors are put. It is a question which is receiving much attention, and which, we believe, will ere long be satisfactorily solved.

Electric Light from Private *v.* Public Sources of Supply.

In another column we refer at some length to an article which appeared recently in one of our contemporaries, in which it is sought to show that the total cost of production of light from a private generating plant, including fuel, interest and depreciation, maintenance and repairs, is less than the cost of obtaining current from the public supply companies' mains, even when the number of lamps installed is as small as fifty 60-watt lamps, the chief fallacy in the argument being that an impossible number of burning hours is assumed as a basis for calculation. It is evident that apart from all other considerations, a private installation cannot commence to be remunerative until the saving in the cost of production, as compared with the price charged by the supply companies, is equivalent to all the costs incurred by the establishment of private generating plant, except those common to both systems. This is a very heavy initial disadvantage against which the private generating plant has to work, and having regard to the various systems adopted by the supply companies upon which the charge for current supply is based, and which are especially designed to reduce the cost of current to the consumer in proportion to the quantity consumed, the number of lamps installed, which would render a private plant remunerative when compared on the basis of actual money cost alone with the supply company's charges is rapidly becoming higher and higher. To take a concrete example, let us suppose that the ideal installation assumed by our contemporary, in which all the 50 lamps were lighted for 1,600 hours per annum, be situated in a locality where the system of charge for current by the supply company is 7d. per unit for the first hour of maximum demand per day and 1d. per unit after, and suppose that during six months these lamps burn for seven hours per day and during the remaining six months three hours per day, the cost per annum, including £1 meter rent, would be £51, which is at the rate of a trifle over 2d. per unit, or less than the estimated cost from the cheapest form of equivalent plant, namely, a turbine with accumulators. There can be no doubt that in large hotels and other institutions where power is used for a variety of purposes, the additional steam power and attendance required for the generation of electrical energy for lighting becomes a very simple matter, but when it becomes a question of putting down motive power and generating plant solely for the purpose of lighting by electricity, the size of the installation which would warrant such a course, is very largely governed by the expediency or necessity of having electric light, and the degree of difficulty or the inadvisability of obtaining it by any other means.

Behr's High Speed Railway.

It is curious to note the absolute neglect on both promoters' and opponents' sides of the real and vital point in Behr's high speed railroad. We can hardly imagine Mr. Behr is so unmindful as might be supposed of the influence of centrifugal force on railroads were we to judge by some of his evidence. He talks of speeds of 120 miles per hour, and makes much of the fact that the centre of gravity is below the rails, as if this mattered one iota. A few phrases from the report of evidence before the Committee here follow:—"In Ireland . . . . curves of no more than 54 feet radius could be rounded at *considerable* speed"; the italics are ours. What does *considerable* mean when speeds of 110 miles per hour are in question and under discussion. "The centrifugal force was met or taken up by pressure on the guide rails." The guide rails will simply serve to hold the carriage level or nearly so as it rounds the curves, but will certainly not take up the centrifugal force of *passengers* who, as we have previously pointed out, will simply hang like so many wet towels over their seat backs if really considerable speeds are run round serious curves. We know by personal experience that an ordinary Midland train will keep the rails round a curve which will throw a passenger over the end of his seat on to the floor. Mr. Behr is not going to alter the facts of centrifugal force by means of guide rails. Evidence of the possibility of safely running the train was brought forward, but has anyone ever doubted the possibility of safely running at any speed on the straight? One witness only, Mr. Shelford, by his use of the words, "up to a certain point," when referring to the comfort of passengers, showed that he had the truth in his mind. There ought to be some evidence brought forward to show that any curves in the line have been calculated for the loose passengers, or we shall see that the speed will be at once limited, not by what the train will do, but by the wet towel attitude of passengers. Has Mr. Behr ever run round a curve with his train at even 40 miles an hour, when loaded with passengers on *both* seats? Since writing the above the Parliamentary Committee has, as will be seen from our report in another column, declared that the preamble of the Manchester-Liverpool Railway Bill has not been proved, which means that the scheme is dropped, at any rate for the present.

THE NEW TELEGRAPH STEAMER "VON PODBIELSKI."

By Prof. JAMIESON, M.Inst.C.E., F.R.S.E

(*Concluded from page* 772.)

The cable drums are each 5 feet 6½ inches diameter on the tread, by 1 foot 7 inches wide between the flanges. They are internally geared, and the outside periphery thereof forms the faces of the brake drums. Consequently, when it is desired to pay out without the aid of the steam engine, this combination drum is the only part of the machine that revolves (except the holding back sheave), whilst the speed is entirely controlled by the brake. The drums run loose on a shaft which is common to both machines, being fixed to the frames and serving as a rigid tie between them. The brake rings are 6 feet 5¼ inches diameter by 10½ inches wide, and the total weight of the combined machine is 31 tons.

The brake screws are worked by means of worm gearing, with the view of obtaining a fine adjustment. Messrs. Johnson & Phillips have, however, made an important improvement upon the ordinary or older form of brakes by fitting them with adjusting nuts, which enables them (after being regulated for any desired tension), to be released as often as may be necessary and re-applied without the possibility of increasing the tension beyond the desired amount.

The brake blocks are made of selected elmwood, securely attached to steel straps. Each brake band has a water service pipe fixed to its periphery, with nozzles at intervals to distribute the water (coming from a Worthington pump) around the face of the brake drum during working, and thus carry off the heat generated by friction, as well as to keep the whole in smooth working order. These brake bands are suspended on springs, so that, when released, they will leave the brake drums equally and simultaneously all round. Moreover, the springs are adjustable, so as to allow for a reasonable wear of the wooden blocks.

The hauling-off gear is driven by means of a patent steel driving chain, directly from the intermediate shaft of the machine. The driven wheel is connected to this shaft by means of ratchet gear, which turns it for pulling back the cable whilst being picked up, and allows it to run free when paying out, thus making the arrangement quite automatic, as against the usual system of throwing clutches into and out of gear.

The first and second motion shafts are carried in a self-contained steel frame, to which the engine bedplates and the main frames are attached, thus making a very rigid arrangement.

The whole machine is fitted on the main deck, just aft of the foremast. The drums, however, rise up through two hatches in the spar deck, and the starting levers, as well as the engine stop valves, and the brake screws are so placed close together, that they can all be most conveniently worked by the engine cable man whilst standing on the upper deck.

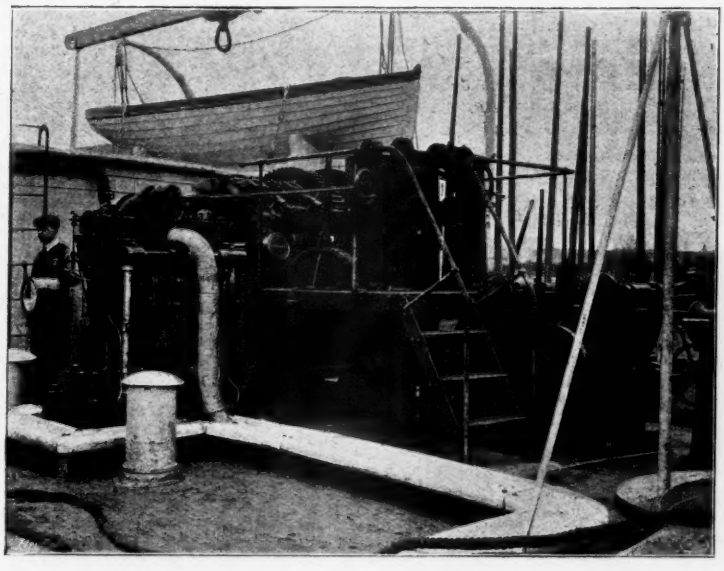


Fig. 7.—"After" Paying-out Machinery of the Cable Steamer "Von Podbielski."

The After Paying-out Machinery.

This gear will be used chiefly for paying out long lengths of cable from the stern, and is consequently a single machine, with only one cable drum and one double cylinder engine. As will be seen from the accompanying figure, it is erected on heavy cast-iron frames, and the drum overhangs these frames. One large gear-wheel and two brake pulleys are fixed on the drum shaft between the frames. These brake pulleys will be run in water tanks to keep them cool, since they will be subject to much longer continuous rotation than those of the forward gear. The brake bands are similar to those of the forward machine, but they are fitted with weighted levers, which is the general practice. An improvement has, however, been applied by the makers, whereby (instead of the weights being made to always act at the same leverage and the brake power altered by adding or deducting weights) the positions of the weights are adjustable along the brake levers by means of a hand wheel and screw, so that the tension on the cable may be varied through a considerable range without adding or deducting any weights. The two brakes can be released bodily by means of a hand wheel and worm gear, and they can also be adjusted so that both act simultaneously or otherwise. A rod at the end of each brake lever is connected with a dash-pot to steady the movement and to obviate any jumping of the levers.

The holding back gear for this machine has double jockey sheaves with brake wheels attached and running in a water tank made of cast-iron, which serves also as the frame of the gear. The shaft of one of the sheaves is connected to the pinion shaft of the machine by means of a steel pitch chain, wheels, and a clutch, so that it will form a hauling-off gear when it may be necessary to pull the cable backwards for any purpose. The cable drum is 5 feet 6 inches diameter on the tread and 13 inches wide between its flanges, whilst the brake pulleys are 4 feet 6 inches diameter by 12 inches wide, and the total weight of the machine is 15½ tons. The engine is of the same type and size as each of the forward ones, and is capable of developing 50 B.H.P. at 250 revolutions per minute with steam of 80 lbs. preasure per square inch. This machine is fitted on the spar deck near the stern of the vessel, just forward of the companion house to the saloon. A working platform is provided above the frames, so that the attendant can watch the cable as it leaves the vessel. All the various levers are arranged conveniently for working from this platform, with the exception of the telegraph to the main engine room and the jockey gear releasing wheel, as clearly shown by the last photograph, fig. 7. A revolution counter is connected to the paying-out drum shaft, and faces the man in charge of the gear, by which and the exact length of cable due to each revolution the total quantity paid out per hour is ascertained. I did not observe any pianoforte steel wire paying-out apparatus for measuring the exact distances traversed, and thus ascertaining the percentage slack of the cable, as has been so successfully adopted by Messrs. Siemens Bros. in connection with their paying-out gear, or any instrument for graphically and continuously recording the dynamometer stresses.

Dynamometers.

The improved design of dynamometer which Messrs.

saving in the cost of production, as compared with the price at any rate for the present.

Johnson & Phillips have supplied, consists of a sheave with a carrier sliding on a central cylindrical tubular column; this column acts as a dash-pot, by having a piston working inside thereof in oil or soapy water. In addition, there is a spring placed inside the column, which comes into action during the lighter tensions on the cable, so that as the spring is compressed the moving weight is correspondingly lessened. This enables a greater scale range throughout the lower stresses, and the corresponding scale readings are therefore not directly determined by the usual dynamometer formula, but by actual trial.

Cable Tanks.

The three circular cable tanks (as shown in vertical section and plan by figs. 2 and 3 in this article), have a total capacity of about 20,500 cubic feet. They are each provided with crinolines, conical centres and opening bell-mouths to guide the cable as it passes into and from them, as well as three very neat sets of indented ladder steps on their inner circumferences, to enable the cable hands to climb into and out of them with having recourse to rope ladders. I should have liked to have seen a fourth tank for receiving short lengths of picked up cable, or the foremast tank divided into two compartments so that the inner one might serve this purpose, even if it had to be a very small one.

Accommodation.

Ample and excellent accommodation is provided for Captain Gertsung, his officers and men, as well as for Mr. Harry Forde, the chief submarine cable superintendent (who is a son of the late Mr. Forde, of Latimer Clark, Forde & Co.), and for Mr. Schneider, the chief electrician, and their respective assistants.

Trial Trip, &c.

At the trial trip, which took place the other day on the Clyde, with very satisfactory results to all concerned in her design, construction, and equipment, as well as future management, it was evident that the *Von Podbielski* would prove not only one of the smartest and fastest cable repairing steamers, but that she would turn out to be easily and quickly handled.

In the previous description I have mentioned two or three minor points wherein additions or improvements might possibly have been made with advantage, and I shall just finish by stating that both the deep-sea and the flying sounding machines, as well as the small turning-over gear, could be better and more effectually worked by small electric motors than by Brotherhood's three-cylinder steam engines, thus avoiding the long exposed steam pipes. Also the search-light projector might with advantage have had slightly diverging instead of parallel rays. It is, however, complimentary to our shipbuilders and cable machinery makers to find foreigners still coming to this country with orders, and thus clearly acknowledging the previous practical experience and excellence of our engineers and electricians.

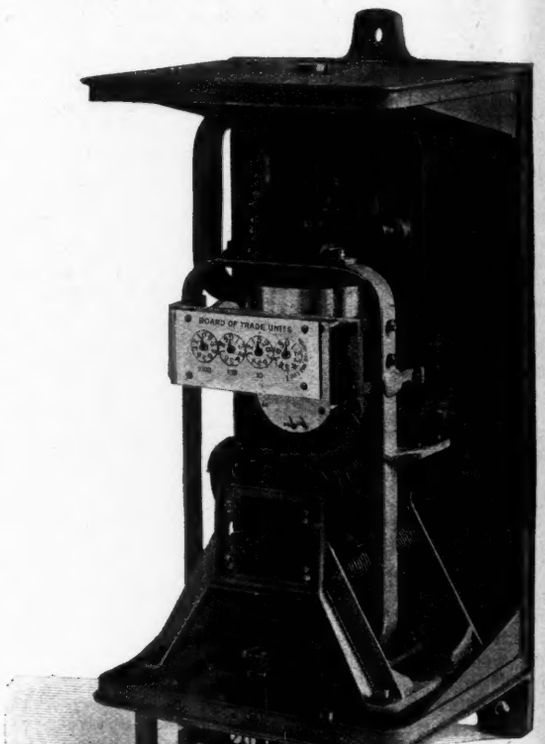
THE EVERSHED METER.

The instrument described by Mr. S. Evershed a fortnight ago before the Institution of Electrical Engineers in his paper on "A Frictionless Motor Meter," is calculated to attract a great deal of interest and attention, and undoubtedly offers a solution of the problem of the motor meter in an unexpected direction. It is a refinement of the well-known Thomson-Houston meter, the principal of which was due originally, we believe, to Messrs. Ayrton and Perry. The action may be recalled here as a text for our observations on Mr. Evershed's improvements, though it is probably better known than any other apparatus of the same kind. On one spindle are mounted a drum armature without any iron, its commutator, and a copper disc. The armature carries a current on a shunt circuit from the supply mains, led in through brushes, and runs in the field of a large fixed coil carrying the main current. The copper disc turns between the pole gaps of one or more permanent magnets. When the instrument is running steadily, the torque on the armature balances the couple of the magnetic brake, and the speed is proportional to the product of the armature current and the main current, and to the watts being taken from the mains.

If the instrument is to work accurately, it must satisfy the following conditions:—

1. The driving torque on the armature must be proportional to the product of the supply pressure by the current, the resistance of the shunt circuit being given.
2. The twisting torque on the brake disc must be proportional to the speed, the conductivity of the disc being given.
3. The conductivity of the disc must be proportional to that of the armature shunt circuit.
4. The torque, resisting the motion due to friction, must be small compared with the magnetic brake torque.
5. For direct current work the instrument must be unaffected by external magnets.

The Thomson-Houston meter meets the first condition exceedingly well by keeping the impedance of the armature circuit practically identical with its resistance, and the



Case only Removed.

mutual induction of the two coils negligible compared with the pressure of the supply circuit. We have never seen any calculation of the difference between the inductance and resistance of the shunt circuit, but it must be very small.

The second condition is also fairly well met. Great care was taken to get constant magnets, and we believe that they have generally proved satisfactory. The condition imposes a fairly low limit of speed on the instruments, since the brake action of a permanent magnet on a rotating disc is not strictly proportional to its speed, owing to what would be called in a dynamo, armature reaction, which at moderate speeds is quite appreciable. We believe that at speeds of 100 per minute the Thomson-Houston meter has no serious error due to this cause, and at low speeds it is negligible. At higher speeds the flux of the magnet is driven outside the disc, almost as if the permeability of copper in motion were less than when at rest.

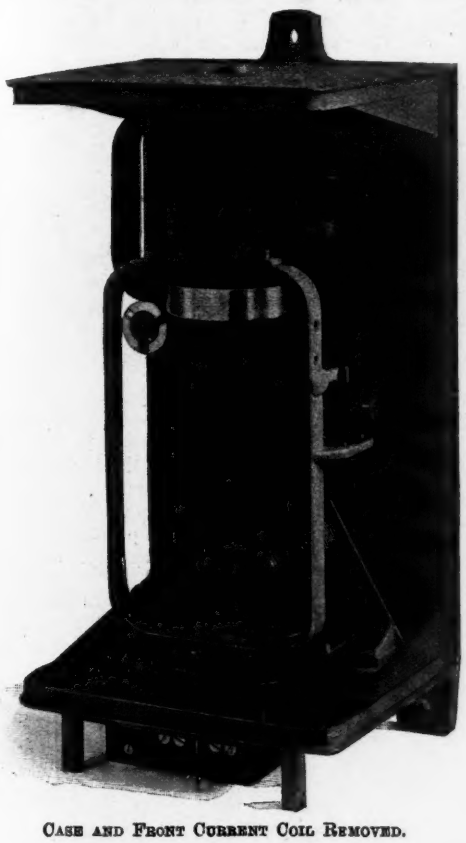
The third condition is fairly met by the use of the same metal, copper, for both the armature circuit and the brake

close together, that they can all be most conveniently worked by the engine cable man whilst standing on the upper deck.

The improved design of dynamometer which Messrs.

disc. As, however, the disc is being continually heated by the eddy currents due to the magnet action, though at different rates at different speeds, while the armature is heated by the shunt circuit at a constant rate, this source of error cannot be wholly eliminated. Here again, however, the restriction of the range to low speeds, requiring small armature currents to drive the disc, may keep the error very low.

The fourth condition was never met satisfactorily by the Thomson-Houston meter, even by the device of the starting coil. The friction occurs in four points—at the pivots, at the brushes, at the counter, and in the air. Mr. Evershed's mode of dealing with the pivot friction appears to be exceedingly satisfactory. Arrangements of the same sort of idea



Case and Front Current Coil Removed.

have been used by many inventors for different purposes, but we know of no case where magnetic attraction has been used to balance gravity so successfully, and the behaviour of the whole moving part of the meter, oscillating with the movement of the table without its rotation being in any way affected, is a very pretty sight. The device of an elastic commutator is a refinement in construction which we believe to be quite new, and is evidently very valuable. The mode of working the counters seems a doubtful improvement. It is decidedly complicated, and appears to be introduced to meet the difficulty resulting from free pivoting rather than to avoid an amount of friction which might be excessively small. Air friction is not dealt with, but is certainly unimportant, and is not widely different from being proportional to the speed.

The fifth condition was never met at all in the Thomson-Houston meter, presumably because this instrument was designed for alternating currents, but is provided for in this meter by the use of two armatures and two field coils.

The net result seems to be that while the great defect of the old meter—friction—is almost entirely eliminated, the other errors, which even then were not important, are largely reduced through the instrument being run at lower speeds. The diagram of the constant of the machine was striking evidence of its range and accuracy, and it is very satisfactory to find it corroborated so closely by the results obtained at the Board of Trade.

The discussion on Mr. Evershed's paper turned mainly on two points, the complication and the noise of the ticking, but Mr. Evershed found no difficulty in replying to both. Complication is, after all, as he pointed out, a question for the makers. Simplicity is no virtue in a machine that won't keep in order, and complication is no objection if the mechanism never requires handling, given of course that it does not increase the cost too much. Prof. Ayrton's illustration of a watch was appropriate. By his design of a magnetic suspension, Mr. Evershed has taught us to do a very useful thing in a very simple way, and probably the lesson will be extensively applied. Possibly his challenge to produce magnetic floating may be taken up. His measurements of the frictional constants of his instruments were interesting evidence of their really scientific design, as were also his diagrams showing the exact effect of vibration on pivot friction.

CONTRACTS WITH CORPORATIONS.

The decision of Mr. Justice Farwell in the case of the City of London Electric Lighting Company *v.* The Mayor, &c., of London, a report of which we published in two recent issues, raised certain points of law which are of considerable interest to those concerned with the supply of electricity. To the details of this case with which our readers are probably familiar, we need not again refer, but there are certain conclusions which can be derived from the luminous decision of the learned judge who tried the case which merit more than a passing notice.

The salient points under discussion in this case were (1) whether a contract for the supply of electricity is one which comes within the scope of Section 42 of the City of London Sewers Act, 1848—(to the text of which we shall presumably refer); (2) whether a person holding shares in a company was "indirectly interested" in the company so as to render void any contract entered into between that company and the Corporation. The text of Section 42 of the Act in question is as follows:—

> That no person, being a Commissioner, or a member of the Court of Aldermen or of the Common Council of the City, shall be directly or indirectly interested or concerned in any contract which shall be made or entered into by or on behalf of the Commissioners for the execution of any works by this Act directed or authorised to be done or executed, or for furnishing materials or labour, *or for any other matter or thing whatsoever*, upon pain that every such contract shall be null and void, and that the person who, being a Commissioner, or a member of the said Court of Aldermen or of the Common Council, shall be so interested or concerned therein shall for every such offence forfeit and pay the sum of £100 to pay any person who shall sue for the same, to be recovered in any of the superior Courts by action of debt or on the case.

The learned judge held that the words which we have printed in italics were not sufficient to include a contract relating to electric lighting, but that the operation of the section must be confined to contracts of construction only. The strongest point in the judgment was that which dealt with the possible consequences of a refusal by the Court to enforce the contracts of the Corporation.

In was contended by the defendants that the mere fact that any Commissioner, Alderman, or Common Councilman is at the date of the contract or afterwards becomes the holder of one share in the contracting company renders the contract void, but Mr. Justice Farwell clearly showed that Section 42 of the City of London Sewers Act, 1848, refers only to what he termed "construction contracts," under which denomination it would be impossible to place a contract for the supply of electric light. "The clause in question," said his Lordship, "if construed as the defendants contend, would create a novel and far-reachin Corporation affecting not only innocent third persons but the and citizens themselves. For example, I am told that the Commissioners are 91 in number, and the Common Councilmen more than 200, and there are besides several aldermen. According to the defendant's contention, if anyone of this numerous body, either at the date of the execution or at any time during the subsistence of a contract to supply gas held a single share in the supplying gas company, the whole contract becomes *ipso facto* and irremediably void."*

* It has since come to our knowledge that the Court of Common Council have passed a resolution in favour of an appeal in this case.

magnets. When the instrument is running steadily, the metal, copper, for both the armature circuit and the brake

Although in the case under review the electric lighting company has been fortunate enough to escape what might have been a disaster, it is useful to know that in all dealings with corporations it is desirable to take care that no members of the corporation are interested in the undertaking of the company. And it requires no very large stake to render a person "interested" in a contract for this purpose. In this connection reference may usefully be made to the Municipal Corporations Act, 1882, where the disqualifications for being elected and for being a councillor are set forth in Section 12 of the Act as follows:—If and while a person (*a*) is an elected auditor or a revising assessor or holds any office or place of profit, other than that of mayor or sheriff, in the gift or disposal of the Council; or (*b*) is in holy orders, or the regular minister of a dissenting congregation; or (*c*) has directly or indirectly, by himself or his partner, any share or interest in any contract or employment with, by, or on behalf of the Council.

But a person is not disqualified, nor is he deemed to have any share or interest in such a contract or employment by reason of his having a share or interest in (*inter alia*) any company which contracts with the Council for lighting, or supplying with water, or insuring against fire, any part of the borough. But for this provision a councillor could not have held shares in a gas or water company contracting with the Council. [Todd *v.* Robinson, 14 Q B.D., 739; 54 L.J.Q.B., 47.]

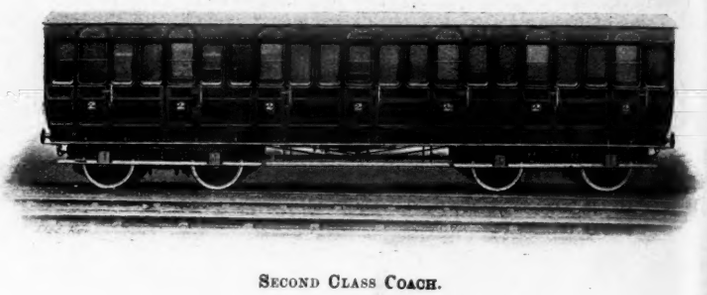
So jealous are courts of equity in all matters where judicial discretion is likely to be prejudiced by monetary interest, that the Lord Chancellor himself has been declared disqualified from adjudicating in a matter which involved the interests of a company in which he was a shareholder. [Dimes *v.* Grand Junction Canal, 3 H.L.C., 759.] And again, where a firm of engineers had contracted with a local board to make alterations to gas fittings in a town hall, they employed the defendant, who was a member of the board and a builder, to erect scaffolding for the purpose of enabling them to effect the alterations. It was decided by the late Mr. Justice Field that the defendant was interested in a contract with the board. [Tomkins *v.* Joliffe, 51, J.P. 247.]

And where a trustee of a turnpike road let his horse and cart at a certain sum to a contractor for works on a road, to be used in the performance of the works, it was held that he was liable to a penalty as being interested in a contract with the turnpike trustees. [Towsey *v.* White, 5 B.C., 125.]

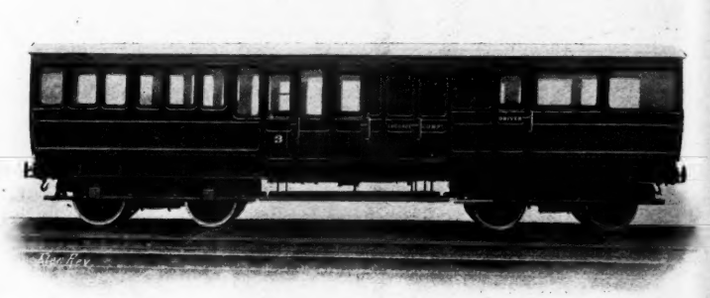
THE METROPOLITAN RAILWAY AND ELECTRIC TRACTION.

On Friday last we paid a visit to the Earl's Court—High Street, Kensington, section of the Metropolitan Railway, which, as our readers are aware, has been electrically equipped for experimental purposes. During the week the electric train had been plying to and fro, in preparation for the opening to the public, which took place on Monday, 21st inst., an epoch which must be regarded as a most momentous one in the records of the "Underground," not on account of the importance of the present undertaking, which in itself is trifling, but because of the fact that this event is but the forerunner of a vastly more weighty occasion—the inevitable conversion of the whole system to electrical operation. In view of this consideration, we give below a brief account of the work which has been done up to the present.

The line itself has been in existence many years, affording an alternative communication between the important junction at Earl's Court and the Inner Circle. It is about three-quarters of a mile in length, and is eminently suited



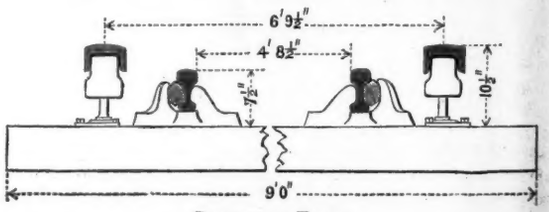
Second Class Coach.



Third Class and Motor Coach.

to experimental needs, including in that short space gradients of 1 in 43 and 47, sharp curves, a tunnel, and cross-over roads; a severe curve occurs on a steep grade in the tunnel itself. The deep dip observed on the up road in our profile of the line is due to this track passing under another railway.

The existing track has been in no way disturbed in carrying out the experiments. The electrical conductors are two in number, as seen in the section given herewith, placed outside the rails at a distance apart of 6 feet 9½ inches, and are maintained at a potential difference of 500 volts. There



Section of Track.

is no connection with earth or with the running rails, and owing to the wide distance between the conductor rails, there is little likelihood of short circuits or shocks to workmen. The conductors are of channel steel, weighing 15 lbs. per yard, carried on ordinary insulators, with a strip of leather to provide an elastic bearing; no feeders are required save the direct connection with the power station.

The train consists of six carriages, comprising seats for 80 first-class, 96 second, and 136 third-class passengers—312 in all. Each carriage weighs about 18 tons, empty, and is 40 feet long, while the width is 3 inches greater than usual. The length of the train overall is 250 feet, and the total weight, loaded, is about 200 tons. The two end carriages, which weigh 54 tons each, include seats for passengers, guard's compartment, and driver's cab; a complete equipment of motors, &c., is provided at each end of the train, which is designed for a "shuttle" service, the motor coach at the fore end of the train being alone used for propulsion.

The electrical gear includes four motors in each motor-coach, with a maximum capacity of 200 B.H.P. each, made

by Messrs. Siemens Bros. & Co., the contractors for all the electrical work; the controllers are of the series-parallel type, with three running positions:—all series, two series and two parallel, and all parallel, each of these being led up to by three resistance points.

The maximum speed attained is 38 miles per hour, while the train can be stopped in its own length by means of a Westinghouse brake. A motor air compressor provides for the brakes and whistle.

Contact is made with the rails by means of shoes, which are attached to each coach, and connected together, so as to bridge over the gaps in the conductors at cross-over roads, some of which are nearly as long as the train. The conductor rails are very greasy in parts, causing some sparking, but this will cease with constant use.

The coaches were built by Messrs. Brown, Marshalls & Co., Limited, Birmingham, and are both handsome and comfortable; indeed, they present as marked an improvement over the old style as the electrical equipment does compared with steam! They are lighted by electric lamps, four in series across the 500-volt terminals.

Power is supplied to the line by means of two Siemens-Belliss generating sets, each rated at 380 amperes, 550 volts, at 380 revolutions per minute; these are very frequently overloaded 50 per cent., without difficulty. The temporary power station is situated near Earl's Court Station, on land belonging to the company. The actual running of the train is most satisfactory; full speed is smoothly attained in a very short time, and the control is perfect.

As our readers are aware, Sir W. H. Preece and Sir J. Wolfe Barry are the consulting engineers.

The installation has been from the start, and is now, in charge of Mr. E. S. Franklin, assisted by Mr. Visger, for Messrs. Siemens Bros.; we are pleased to add that the whole of the work is of home production.

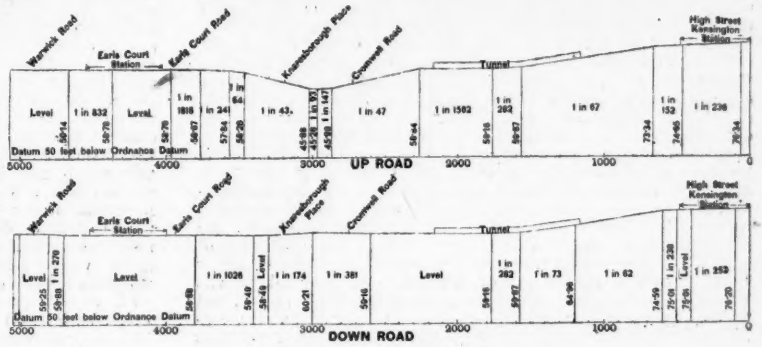


Diagram of Gradients.

LEGAL.

Chamberlain & Hookham *v.* the Corporation of Bradford.

(*Continued from page* 821.)

Friday, May 11th.

When the Court reassembled on the 11th inst. Mr. Cripps resumed his speech for the defence. There were, he said, no directions or description whatever to enable alternating currents to be used in Chamberlain & Hookham's specification. There were a million of the Thomson meters in use, and 90 per cent. of them had been applied to alternating currents. Therefore upon that no question could arise regarding alternating currents whatever else his Lordship might think the defendants had infringed. Nor was there any question that the defendants had infringed the plaintiffs' armature. They had not done that at all. The next point was with regard to the commutator. So far as that was concerned, the defendants used a system absolutely distinct from what was suggested in Chamberlain & Hookham's patent. That patent said, "To avoid the friction of a brush." Now, the defendants used a brush, and got rid of the friction in an entirely different way from Chamberlain & Hookham. The defendants used brushes, and their whole system, so far as the commutator was concerned, was so distinct between the plaintiffs' and the defendants' systems that they could hardly be compared. In the plaintiffs' there were the mercury cisterns. In the defendants, there was the silver. In the one there was the vertical arrangement, in the other the horizontal. Both got rid of the friction. In his evidence Mr. Hookham himself admitted that the defendants' commutator was materially different from his own. All the machinery connected with the commutator in the defendants' meter was different from his own. In fact, the defendants' solution of the difficulty of friction was absolutely different from the description in the specification of Hookham's patent. The defendants did not employ mercury in any way. Mr. Moulton had referred to the introduction of grooves in order to increase the strength of the eddy currents. Of course there were no grooves in the defendants'. He should like to bring to his Lordship's mind that in the Johnson & Phillips' case there were grooves. What the plaintiffs did was to invent a particular form of magnet with a number of bars, and to which Imray had called attention in his specification. He said that the ordinary horse-shoe magnet might be made up.

Mr. Walter said Mr. Justice Wills found that the pole-pieces were not grooved. He held it was a mere continuous pole-piece.

Mr. Cripps wished to say a few words about the point of constancy and power. What was put against the defendants was that the plaintiffs in their combination did use a magnet for braking purposes which was both constant and powerful, and the merit, or the claimed merit of it was in the combination of constancy and power. Constancy, of course, could be obtained merely by ageing. So far as power was concerned, it was simply this. The greater the power you had on the magnet the slower were the revolutions of your meter. The advantage of that was in altering the measuring power of your instrument. In the one case the meter revolved more quickly than in the other, and wore out more quickly. There was no principle involved in that. It was merely a question of degree.

His Lordship said he thought Mr. Swinburne said that before Hookham, constancy and power were mutually distracting and were co-existent.

Mr. Cripps said he thought that the effect of Mr. Swinburne's evidence was that constancy and power were well known in every sense, and what Mr. Hookham really did—he (counsel) must give him every credit for this—was to invent, according to Mr. Justice Wills, a form of permanent magnet. Mr. Justice Wills, however, had never found that every magnet which happened to have constancy—of course, every magnet had some, as ageing was well known—was an infringement of what the plaintiffs did. It was only a question of degree. The defendants had constancy, and a small power was sufficient for them. He supposed you could not have a magnet without power, and a magnet which must have power must have constancy. What Mr. Hookham did was to describe a particular form of magnet in which he had both constancy and power. It would really be incredible and impossible to say that no constant magnet was to be used by anyone except Mr. Hookham, because every magnet had some power.

His Lordship: You say the idea of combining constancy and power was not patentable. You say you use an entirely different kind of magnet, and that you are entitled to do so.

Mr. Cripps agreed: He contended that the plaintiffs in the present case were in a peculiarly weak position as inventors. All the principles were thoroughly ascertained and known, and the most they could claim was the particular form of application. Bearing in mind what he had said that power here was only a matter of degree whether the brake spun a little faster or a little slower, they got just the same recording instrument by either one or the other. Then Mr. Hookham said in his specification that for small installations he "preferred" a number of small magnets—bar magnets substituted for the large magnets in the drawing. There they had Mr. Hookham saying—very properly—that in place of electro-magnets he "preferred" a particular form of magnet, that form being a number of bars with artificial iron poles. When that was done—that was to say, after this arrangement of bars and poles had been built up, the permanent magnet was practically constant. But that was not the essence of Hookham's invention at all, but merely a direction of a preferable way of carrying it out. The claim in the plaintiffs' specification was (1) "An electricity meter for measuring currents, consisting of an electromotor with constant field, arranged substantially as hereinbefore described and illustrated in the accompanying drawings, the said electromotor being combined with an electric brake also moving in a constant or nearly constant field, preferably the same field as that in which the armature rotates, substantially as herein described." Now, that was quite distinct from the defendants' meter, which was a meter for measuring energy, and which was absolutely distinct as a machine, and also distinct as to all the chemical agencies employed. The plaintiffs' claim said: "An electromotor with constant field." The defendants did not do that; it would be absolutely destructive to them. And then the plaintiffs said: "Arranged as hereinbefore described." Well, but the defendants' whole arrangement was absolutely distinct in every feature from the plaintiffs, so far as the motor was concerned. It was quite clear to his (Mr. Cripps's) mind, with regard to this first claim, that there was no infringement. The defendants' arrangement was a different arrangement, applied differently, and for a different object. Then the third claim which was relied upon was this:—"In electricity meters, the use for the

purpose of procuring a powerful and constant magnetic field of permanent magnets arranged as described, with very large polar surfaces closely fronting each other so as to form a narrow slit in which the disc armature revolves, whether the same be magnetised in position or otherwise, and the means described for regulating the same when or if necessary, substantially the same as herein described and in part illustrated in the accompanying drawings." Mr. Moulton had carefully confined himself to only reading that claim, without making any comment upon it. That claim, however, did not carry the matter any further than the first claim, and everything, therefore, turned upon the first. The others were subsidiary incidents of the first—they simply followed what had gone before. As to the disc armature, the defendants were outside that. The claim was for a disc armature—a powerful and constant magnetic field for the disc armature of the motor. In the defendants' machine a disc armature was not the motor, and there was no constant field at all. So they came to the magnet point, which seemed to him to be the litigious point between the parties. On that point, material evidence had been given in this Court which had not been before Mr. Justice Wills at all, and he (Mr. Cripps) thought the evidence here given was absolutely conclusive on the point of infringement. Mr. Justice Wills found that the plaintiffs' specification contained all the theory on which Mr. Hookham based his invention, and that it had not been done before. But here, in this case, the defendants had shown that it had not only been previously disclosed in principle, but had been practically carried out before Hookham's specification appeared at all. If he (Mr. Cripps) could point out that what Hookham did by his patent had, both in theory and practice, been previously disclosed, then what became of the suggested invention? It was clear that Marcel Deprez knew the theory. So far as the brake was concerned, it was nothing but a question of degree. It merely meant whether the copper plate ran slower or faster. Those which ran the quicker wore out the quicker. The learned counsel submitted that these things were well known, and that the defendants were entitled to take advantage of public knowledge. He next referred to the magnet, which he said the defendants had induced Prof. Ayrton to take out of an ampere measuring meter made 18 years ago. This magnet he said had been in use for 18 years—long before Chamberlain & Hookham's specification—and had been perfectly constant for 18 years. As regards strength, it was, as he was told, a great deal stronger than the magnet which the defendants used. Prof. Ayrton had tested that magnet which had been in use for 18 years, and found it was constant and more powerful than the magnet which the defendants used. The answer, therefore, was that there was no question of theory. Could it then be said that it was infringement for the defendants to use a magnet of that constancy and power? Constancy could be obtained by a well-known method, and as regards the combination of constancy and power, it was merely a question of degree. He would not trouble his Lordship with Ayrton and Perry's specification, because it was admitted on all hands that they disclosed the whole theory. He must take Mr. Justice Wills's judgment that they did not go beyond the whole theory. The difficulty Ayrton and Perry had to contend with was the friction theory. The learned counsel next referred to Abel's specification of 1884. He said that there was really no difference in form between the magnet there and the one used by the defendants. As Mr. Swinburne had said, if three or four of those magnets had been put side by side, they got the defendants' exactly. There was also claim 5, which was:—"The construction and arrangement of parts forming a commutator making contact by means of mercury placed in insulated vessels, the axis of revolution of the commutator being vertical substantially as hereinbefore described." He would not dwell on that now, but he mentioned it, because it was a point that might be raised hereafter on the question of validity. But to sum up his argument, he would say this. He would not say it was admitted, but there was no serious dispute that the defendants' machine or combination was quite distinct from that of the plaintiffs. It was for energy in the one case, and for current in the other. It was admitted also—or not seriously disputed—that the claim of the plaintiff was entirely based on a law known at the time, and was for a combination carrying out what was then a well-known law. So far as motor power again was concerned, the machines were distinct. The real difficulty felt at the time was as to friction; and, so far as mechanical means for getting rid of that difficulty of friction were concerned, those of the defendants were entirely different from those of the plaintiffs, and the theory of getting rid of it had been disclosed in an article published before the date of plaintiffs' patent. As to the brake, the only matter claimed by Mr. Hookham was constancy and power, and Mr. Swinburne had told the Court that both were matters of degree. So far as constancy was concerned, the defendants used a method well known before Hookham's, and so far as power was concerned, it did not matter whether one magnet was of a certain power as compared with another. The defendants used a magnet distinct in form and power from that of the plaintiffs. The defendants used simply the ordinary common form of magnet, and viewing all the facts, he submitted that there was no substantial kind of infringement here at all.

Evidence for the defence was then called.

Mr. S. Z. de Ferranti, examined by Mr. Cripps, said he had had great experience in all electrical matters. He was one of the first electricians to deal with the question of meters, his first attempt to make one being in 1882. He succeeded in his attempt at the end of 1883 or beginning of 1884. He then produced a continuous current meter, and it had been very largely used since then.

Mr. Cripps: It has been suggested that Mr. Hookham first solved the difficulty of measuring currents by meter. Is that so?

Witness: No. I saw his specification directly it was out or printed, and I thought at the time that it described a very inferior instrument to the one I had already produced. That might sound egotistical, but I did think that the patent was a retrograde step.

Continuing, the Witness said that the sale of electrical meters came into commercial use in the latter part of 1886. Very little was done with regard to electrical meters before 1886. In fact, there was no commercial demand for electrical meters before 1888. The meter produced (one of Ferranti's) was an example produced in 1884, and shown at work at the South Kensington Exhibition—at the Health Exhibition, or one of them—on a lighting circuit. It was found in practice that the meter would start with a single lamp, and measured up to 20 lamps with very fair accuracy. The business in these meters had rapidly increased, and at the present time there were perhaps 40,000 of these current meters being used in England of that pattern, but not of that particular shape. It was not really until 1888 or 1889 that electric lighting had made any advance in England. The defendants' meter was an energy meter. An energy meter was entirely distinct from a current meter, and was totally different. In a current meter you must have one element constant, viz., the field or armature. In the defendants' meter it was not necessary to have a constant field in connection with the motor. To have constancy in an energy meter would be destructive. He was acquainted with the arrangement of Mr. Hookham's meter with regard to the friction. He thought it was a bad arrangement, and did not succeed in getting a low friction. He did not find any similar method of dealing with the friction in the defendants' meter. The commutator in the plaintiffs' meter was distinct from anything he found in the defendants' meter. It was one of the elements which he considered unsatisfactory in the plaintiffs' meter, and which was satisfactory and proved to be good in the defendants. The defendants' form of commutator was a very special form. The commutator was a very important factor in producing an effective meter. Before the Chamberlain & Hookham patent it was known how to make a magnet constant. In his view the question of friction was most vital, and the reason was that it was most necessary to get a meter to start readily. Unless it started readily with a small amount of load upon it, it would not earn revenue upon the lamps left burning all night—lamps burning, perhaps, 18 hours out of the 24. Commercially, it was most vital that the meter should start well, and in order to get good starting you must have low friction. There was nothing new in getting constancy. There were several processes of getting constancy known as ageing. Ageing reduced the power of the magnet perhaps some 15 per cent. For the purposes of the brake it was necessary, besides constancy, that the magnet should be powerful, so as to prevent the meter running too fast and so wearing itself out. Supposing the defendants had a weaker brake than what they used they would get a measuring instrument which would wear out faster. There was no difference in the principle whatever; it was only a matter of speed. It was a commercial element only, and did not affect the electrical law. He had made himself acquainted with the special form of magnet in the Chamberlain & Hookham machine. In the defendants' machine a very ordinary form of magnet was used. It was a "common" form of magnet, and that was all that one could say about it. In the defendants' machine one could put in as many of those magnets as they wanted—two or four, or any number necessary to get the best speed for their meter and brakes. It was merely a commercial question. There was no difference between the motor part of Siemens's instrument and the defendants', except that the latter had got the silver commutator. Otherwise it was exactly the same. He had read the Deprez article. That article also stated the general law with perfect accuracy on the subject. It referred, further, to the question of magnetic speed.

Mr. Cripps: I ask you, as an electrician, would those figures (illustrations shown), if carried out, give a permanent magnet which would serve the purpose, with a copper disc as a brake?—It would be perfectly useful, and a very satisfactory form in which to apply a magnet, and you could put more magnets on it if you liked. There is no difference between what I find described in Siemens's and Deprez's and the defendants'. He had seen the magnet now submitted to him (magnet produced) working for six months with its meter, and he was confident that it was constant. It was at the commencement of the period of running that a meter would lose force; but if he found one going constant for six months, then he knew that it had real constancy. He should have had no difficulty in producing an energy meter such as was used by the defendants, from the descriptions in these articles. Mr. Uppenborn also, in his article, showed that he had a perfectly complete and clear understanding of the whole subject.

Mr. Cripps: Supposing you were dealing with the question of a powerful motor, you obtain it by the plaintiffs' specification by means of a strong permanent magnet with a constant field?—Yes, and in the defendants' you get it by another way; you get a permanent magnet in a constant field. The motor in the defendants' meter is made of two parts—the armature and the field. The field in this (the defendants) is a magnetic field in air, and is formed simply by the passage of an electric current. No iron or steel was used in either the field or the armature in the defendants' meter. In fact, the two machines were absolutely different things.

At this stage the further hearing of the case was adjourned until Monday.

Monday, May 14th.

When the hearing was resumed, as Mr. Ferranti had been unavoidably detained, his cross-examination was deferred, and Mr. Cripps for the defence called

Prof. Ewing, who in answer to questions, said he was a Fellow of the Royal Society, a member of the council of the Institution of Electrical Engineers, a member of the Institution of Mechanical Engineers, and a member of several other scientific bodies. He had given much attention to the subjects of electricity and magnetism, and had made himself acquainted with the meter used by the

defendants, and had carefully studied the plaintiffs' specification. Having done so, he could not say that the defendants' meter infringed the specification in any way. The specification was for a meter to measure electric currents, and the defendants' meter was an energy meter. In order to get a current meter it was necessary to design the arrangements so as to ignore the magnetic force and secure a constant field for the motor. The other meter was sensitive, and the variation was vital and essential. The energy meter could be used for all sorts of purposes. So far as there were special mechanical methods for dealing with the question of friction the defendants' machine was not an infringement of the plaintiffs'. There was no resemblance between them. For instance, the commutator in the defendants' was quite different from that described in the plaintiffs' specification. The defendants used a form of commutator which was known for many years before the date of the plaintiffs' specification. It was known how to get constancy before that date. The defendants' magnet in no way infringed that described in the plaintiffs' specification. It was absolutely different. The use of a permanent magnet to create power was well known before the date of the specification. After the article which was written by M. Deprez, which was very clear, an electrician with a knowledge of his subject could easily have made such a meter as that used by the plaintiffs. The power they wanted on the motors was the driving power, and they wanted a powerful motive power to reduce friction, so as to make the friction a negligible quantity. So far as driving power and motor were concerned, those of the defendants' and of the plaintiffs' were quite distinct. As to the brake, supposing they had a particular strength of magnet on the brake, the speed would depend on the motor as counteracted by the brake. One description given by Faraday of a magnet might be construed as describing something very similar to the magnet set forth in the plaintiffs' specification. In order to get constancy, they wanted a magnet which should be as nearly as possible a closed magnetic circuit so as to reduce the loss of power; but there were other conditions equally important. There was nothing in the defendants' magnet which was not compatible with what had been known and described prior to the plaintiffs' specification. Witness was shown a magnet which had been constant for 18 years, and said that, as compared with it, there was nothing different in the plaintiffs' specification There was a difference in the building up, but the principle was the same, and had been known for some years before. There was no basis for the suggestion that at the time Mr. Hookham made his experiments permanent magnets had been practically abandoned for the purposes for which compensation was required. They were in actual use. In Ayrton and Perry's specification of 1882 there were described the principles of the law which were contained in Chamberlain and Hookham. It was common knowledge, and there would be then no difficulty in getting a magnet constant and of sufficient power. He had read in the plaintiffs' specification the description of what had been called in this case the vertical commutator, but that idea was not novel. Witness was shown two models of earlier instruments than the plaintiffs' specification, and said that each had a vertical commutator such as was described in the plaintiffs' specification. Taking the words "disc armature," *per se*, in the specification, he, as an electrician, would at once understand that the words meant the armature of the motor. Witness pointed out that in the specification Mr. Hookham said that the armature consisted of so and so, the commutator consisted of so and so, and the brake consisted of so and so.

Cross-examined by Mr. MOULTON: The defendants were actual users of their machine. In his specification the plaintiff stipulated for a constant field, or as an alternative, an armature of steady power.

By his description in the specification, it is plain that the plaintiff intended to use the same connections in his magnet as you find in the defendants?—I think that is so.

The specification says that the electromotor might be of any of the ordinary kinds then in use. At that time there were alternating current motors?—Yes.

And they were made exactly as in Siemens's meter or the defendants' meter?—Yes.

Continuing, Prof. EWING said: The defendants' meter measured energy, and never measured anything else but energy, not one particle of the general principle of the plaintiffs' meter was applicable to an alternating current meter.

Questioned with regard to the getting of constancy and power in permanent magnets, the WITNESS said he could point to many passages in specifications, &c, prior to the Hookham specification for getting constancy and power in permanent magnets. The witness cited Elphinstone and Vincent, Siemens, Faraday, Jamin, Deprez, D'Arsonval, and Ayrton. D'Arsonval's reference was a paper on electric telephones on concentric poles. It referred to the shape of magnets which were found to give good results in speaking on telephones. One pole was in the shape of a ring, and the other pole coming up in the centre, both on the same side of the telephone plate.

Mr. MOULTON: How in the world could these instructions tell the world the right way to get a good magnet for your brake?—They showed the form of magnet which gave good results for whatever purposes they were used.

Is there any suggestion here that the magnet was constant or powerful?—Well, it gives good results.

I put it to you that the words, "increases the effect," refer to the giving a clearer sound?—It might be so.

May I put it to you that of all the things least of importance in a telephone, constancy is one?—Well, of course, constancy is not of nearly so much importance in a telephone as in a meter.

Questioned with regard to Jamin's references to magnets, the witness could not agree that Jamin's work was directed to increase the portative power of magnets. Jamin spoke of an instrument in which constancy was important. He could not say whether Faraday at page 117 was talking about bar or horse shoe magnets. He thought the whole of what Faraday said was applicable to magnets of all forms.

Prior to 1887 had you ever seen one of the specifications cited in this case?—Prior to 1887 I was not much interested in specifications, but I certainly had seen some of Marcel Deprez's writings.

Can you say you have seen one of these other publications?—Yes. I have no doubt that I read Faraday. I had certainly seen extracts from Jamin, but I had not read all his papers.

I ask you about the actual passages cited here. With the exception of Faraday, can you say you had seen any one of these passages cited in this case?—I cannot at this date specifically refer to any of these passages as having been seen by me before, but I may say this, there was nothing contained in those passages I was not acquainted with.

Cross-examination continued: He had not suggested that ageing took out something like 15 per cent. He did not think it ever had the reputation of taking out the larger part of the magnetism. It would all depend upon the kind of steel used.

Mr. MOULTON: It does not take more money to make a good magnet than a bad one if you choose the right form, does it?—Well, the process of ageing is, I think, one of cost. You have, of course, to pay more for good magnet steel than for bad magnet steel.

Questioned further, the WITNESS stated that the defendants' was a cheap magnet so far as geometrical form was concerned. Abel's instrument was a current indicator. He had never seen an Abel meter. He thought the invention was practically the same as that by M. Lippmann which Witness had seen.

Re-examined by Mr. CRIPPS: The saturation of an electromagnet was in all cases a question of degree. No electromotor with constant field could be used for measuring alternating currents.

If you wanted a meter for alternating current, could you use the same field both for the motor and the brake?—No, it is quite impossible.

Do you know within what range of power the defendants use their magnets on different meters?—I am told it varies as much as 50 per cent. I have noticed there are wide variations in the power of the magnets they use.

Further re-examined, the WITNESS stated he considered that from the directions given in the paper of 1884, "Siemens's Energy Meter," any competent workman could have carried them out and actually made the meter.

Prof. WM. EDWARD AYRTON, F.R.S., examined by Mr. GRAHAM, said he had devoted a good deal of attention to the question of the constancy of magnets. Constancy of magnets really depended, in the first instance, and to a very important degree, on the constitution of the steel—the chemical composition of the steel. Secondly, it depended very materially on artificial ageing. Lastly, but to a much smaller extent, it depended upon the geometrical form into which the magnet was made. At the date of the Hookham patent he knew how to make, and had made, a constant and powerful magnet. He had studied the manufacture of the defendants' magnets in common with Prof. Thomson at the works in Massachusetts, where they were made in large numbers. The magnets were made out of steel heated to a dull red heat. Then there was a very special form of ageing. They were dipped 20 times successively into boiling water and into cold water, the operation occupying 13 hours. A large number of magnets were hung on a kind of chain arrangement, which was kept rotating continuously. That was how the magnets were made constant. Prior to the ageing the magnets were made into powerful magnets. The defendants used a very ingenious device to magnetise their magnets. It was not the fact that at the date of Hookham's specification permanent magnets had been abandoned where absolute constancy was required. Mr. Hookham did not teach the world for the first time how to make a powerful and constant magnet. He did not teach the world how to make either a constant magnet, or a powerful magnet, or the two combined. Witness knew how to do it years before Hookham's specification was lodged.

Referring to the Ayrton and Perry specification of 1882, the WITNESS stated that the only thing which prevented them from making a successful commercial meter was their not knowing how to make the armature and brushes with sufficiently small friction. The difficulty of getting a constant and powerful magnet did not stand in their way. He was in Court when Prof. Ewing was examined, and agreed with him that Hookham's specification gave no directions how to make a satisfactory alternating current meter. He did not think that an intelligent workman could have made a successful alternating current meter after reading Hookham's specification.

Cross-examined by Mr. MOULTON: The plaintiffs' meter consisted of an electric motor with constant field. It was not a sufficient description, in his opinion, to say it consisted of an electric motor and brake.

It has those two parts in it?—Yes, with another addition which is vital—the constant field.

Cross-examination continued: Electric motors, both for direct currents and alternating currents, were both known. If it were wanted to have an electric motor with alternating currents, you must have the alternating current both in your field and in your armature. He hoped every electrician would know that. Supposing you wanted to get an electric motor for alternating current, a permanent magnet could not be used. He did not tell his Lordship that he thought Mr. Hookham considered he could make an alternating current meter with a permanent magnet as the field. In the plaintiffs' meter he said that the mercury commutator did not work. He found, for example, that by putting a little mercury into the cup he changed the reading by 15 per cent. There was no indication on the meter how much mercury to put in. The hearing was again adjourned.

TUESDAY, MAY 15TH.

THE hearing was resumed on Tuesday, when Prof. AYRTON was further cross-examined. This duty was undertaken by Mr. Walter, as his leader, Mr. Moulton, had been required to attend at the House of Lords in an appeal on another electrical case.

In answer to Mr. Walter, witness said that the defendants' magnet by two processes was reduced in power, but still it was a strong magnet.

Mr. Justice FARWELL: Is there any definition of "strong" in connection with electricity?

WITNESS replied that there was no definition of strong. They might have 900 lines or 1,000 lines. They were both powerful. But the term strong was only relative to something else with which it was compared. The defendants' was a magnet which had not a third of the braking force of his sixteen-years-old magnet.

Mr. WALTER: You have spoken to this effect—that for the purpose of braking you prefer concentrated poles?—Yes.

Concentration at the expense of the magnetism is a disadvantage?—I do not know what you mean by concentration there.

I ask you to assume that concentration can only be attained by the loss of magnetism. The widening of the poles then would be an advantage?—It is not true. Assuming what you state—which I must qualify as not being true—then it would be a mistake to have concentration because constancy is of great importance; but my own experiments show that you can get concentration and constancy.

With a strong magnet?—With a strong magnet. Continuing, witness said that in Drage's paper, he showed small weights which made contact, and which went over the top of the projector, and it showed how to make Siemens's armature to work with the mercury commutator. The model before him showed how to use the pools of mercury higher in the middle than at their sides.

Re-examined by Mr. CRIPPS, WITNESS said that the defendants' magnet was of a form well known to him before the date of the plaintiffs' specification. There was no reference in the plaintiffs' specification to the use of silver for the purposes of the commutator. The defendants' meter was merely the Siemens meter with the Deprez addition to it, and with silver in the use of the commutator, no reference to which appeared in the plaintiffs' specification from beginning to end.

Mr. FERRANTI was then recalled. In answer to Mr. CRIPPS, he said that if there were any description in the plaintiffs' specification of the current meter, then it was a deficient description; and, so far as the instrument was described, the meter would not work at all with alternating currents. He did not think the thing could have been understood when it was written.

Cross-examined by Mr. WALTER, Mr. FERRANTI said that in 1887 it was not generally known how to make alternating current motors, but present knowledge showed that with the then existing descriptions and instruments, they could have made instruments which would have worked with alternating currents.

Mr. WALTER: You have spoken about the constancy of permanent magnets. Before the date of Hookham's specification, what do you say as regards what was known of the constancy of permanent magnets coupled with strength. As I gather, what had been done was to expose the magnets to some of the conditions to which they would be exposed in use—such as temperature—until they got down to the condition in which, when in use, normal circumstances would not affect them?—Yes, they were subjected to conditions whereby, when put in practical use, they would not be affected by similar conditions afterwards. He thought that the silver brushes were very important and more durable and certain than copper ones. He was "afraid" he was an inventor. He did not say he would have invented Hookham's, but speaking from knowledge common at the time of the specification, the instrument could have been made. The information others had given left nothing to the imagination. Uppenborn and others had fully described the theory, and how to carry it out in every detail for a commercial meter. There was no suggestion as to making the brushes with silver, which, witness considered, added to the life of the meter, but otherwise the knowledge before the specification was sufficient.

Re-examined by Mr. CRIPPS: Mr. FERRANTI said that both the theory and practice of the instrument were set forth by Deprez most completely. Siemens would have worked for a long time with copper brushes, but silver was better. It was a refinement of practice. The plaintiffs' commutator was intended to be an improvement in practice, but it had not proved so. Witness would not measure alternating currents by an arrangement consisting of an electromotor with constant field. The arrangement in the specification was, in his opinion, entirely wrong. The difficulty of the Hookham meter, as an alternating current meter, was that the magnet proposed did not vary at the same time as the current in the armature. This was quite a complex electrical matter to anybody but a technical person, but if anybody tried to construct a meter on the lines shown by Mr. Hookham, he would get something which was utterly and hopelessly wrong.

Prof. SILVANUS P. THOMPSON, examined by Mr. BOUSFIELD, said that in the plaintiffs' specification the first method of getting constant field was by getting permanent magnets, and the other by having electro-magnets which were saturated.

By Mr. WALTER: If made on the lines described in the specification, the instrument would not work as a current meter.

His LORDSHIP remarked that in making his instrument the plaintiff might not have adhered to his specification, and one answer expressly stated so.

This closed the evidence in the case, and Mr. BOUSFIELD addressed the COURT on behalf of the defendants. He desired to recall the fundamental principle that they wanted in a meter to register accurately the number of amperes passing through it. The current meter registered equally every hour whether the voltage was increased or not, whereas the energy meter registered the current multiplied by the increased force. The defendants' meter was an energy meter, and yet the plaintiffs said it was an infringement of their current meter.

In an energy meter they had two requisites, first the outside field, which was of large wires—if small they would become too hot—and they had the interaction of the field, a fixed part, and the armature the moving part. There were two interacting things, fixed coils and movable, with a current passing through them. The difference between this case and that before Mr. Justice Wills was this. In the case before Mr. Justice Wills, the defendants had the current meter. They had a meter with a permanent electro-magnet built up with pole-pieces at the ends; and the armature was of the plate type, so that they had the arrangement which Hookham had described in his specification as using a disc or cup at once as a motor and a brake. They had, therefore, absolutely identical elements which made a current meter—a constant field with an armature developing the proportional force of the current, varying with the potential. The defendants had not, in that case, the Siemens meter. They had infringed with a current meter. But in the present case they had an energy meter identical with Siemens. The substantial points which differentiated the two instruments were these In the plaintiffs' they had first a constant field, next special arrangements for minimising friction, and third, strong power in order to reduce friction. Every witness, he thought, agreed that the difficulty of overcoming friction was the real practical difficulty at the time. Hookham made his driving force very large, and the friction consequently very small. In the defendants' meter, so far from having constant field, there was a field, one component of which varied with the current and the other component of which varied with the electrical force; and their method of reducing friction was now very different from that of the plaintiffs'. Mr. Justice Wills had treated permanent magnets in the case before him as if they were not an essential of the first claim, which only dealt with the constant field.

Mr. Justice FARWELL: Mr. Moulton puts it forward that what you have done is a breach of Claims 1 and 3, and Mr. Justice Wills said it was a combination of all the elements.

Mr. BOUSFIELD thought that Mr. Justice Wills did not mean that. When he said it was a combination he was referring to the combination in the first claim, and he went on to say that he had come to the conclusion that there was substantial identity—in other words, that a case of infringement of the first claim was made out, but on the sixth claim—improvement in pole-pieces—Mr. Justice Wills found that the defendants had not infringed that. Therefore combination of all the elements of the whole of the claims could not have been meant. And as to Claim 3, that was a claim for something less than the whole thing which was claimed in claim 1. But, having regard to the fact that that third claim dealt with something not in the provisional specification at all, he (Mr. Bousfield) submitted that it was a claim which could only be infringed if one used a motor such as was substantially described in claim 1. He submitted that if the defendants did not infringe claim 1, they could not infringe claim 3. Claim 3 was only a detail in the working out of the invention in claim 1. Plaintiffs had a magnet with big ends in order to get a powerful motive force; and the defendants had a very different arrangement, for although they also obtained a powerful driving force they had no iron, and they relied on two coils—the coil which carried the current and the inner coil. The difficulty of getting over the question of friction was got over by the defendants also in a way very different from the arrangement adopted by the plaintiffs. Both as regarded the powerful field and the diminution of friction, the defendants were working on different lines from the plaintiffs. Continuing, the learned counsel said that, of course, the defendants had got an electric brake moving in a constant field. Their defence with regard to infringement might be summed up in the broadest way in saying that the plaintiffs' was a patent for a current meter, and the defendants' was an energy meter. The defendants also said that they did not infringe, even if his Lordship took his learned friend's point about its being used in a constant circuit, so as to be a current meter. Even if his learned friend was right about that, still he (Mr. Bousfield) should say it was not an electromotor substantially as described, because it had got a constant field. It had not got an arrangement for giving a powerful driving force, and for minimising friction which were really the features which governed the construction in the plaintiffs' specification, so far as the motor was concerned. Up to a certain point the defendants' was accurate as an energy meter, but after that point it ceased to be a meter at all. The learned counsel next referred to the third claim, and the question of infringement on that head—viz., the question of disc armature. He said that really this claim was never intended to cover either the use of permanent magnets for the motor, or for the motor and brake combined. The case actually illustrated, was the motor and brake combined—one disc. He submitted the words "disc armature" showed that the claim was never intended to apply to the use of permanent magnets in the motor or the motor and brake combined. The claim had no application for magnets used solely for braking purposes. Of course, this was an additional point to the other points.

His LORDSHIP: I thought you did not take this magnet?

Mr. BOUSFIELD replied that that was so, but a great many points were raised about that, and it was necessary to deal with them all. He submitted that the claim in question was never intended to apply to the use of constant and powerful magnets in connection with the brake, but only in conjunction with the disc armature. Referring to the magnets the learned counsel said it could not possibly be said the defendants used the form of magnets invented by Mr. Hookham. The defendants' principle was to let the magnets down to such a point as to make them sufficiently constant. They then took two or three magnets, or more if necessary, in order to get the required power. That was to say, the defendants got their constancy in the old way, and got their power not by any special

construction of magnet but by having two magnets, or, if necessary, three or more until they got power enough. He contended that Mr. Hookham, although he mentioned an alternating meter in his specification, excluded it in his claim. Referring to the alleged anticipations of the plaintiffs' patent by Siemens and Deprez, so far as the principle of constancy and power in the magnets was concerned, the learned counsel said that the defendants' point on that was that they were following the line laid down by Siemens. If the plaintiffs said that their specification excluded the defendants', the defendants' answer was that the plaintiffs going on that line, destroyed their own specification, because what the defendants did was like Siemens.

The hearing was again adjourned.

WEDNESDAY, MAY 16TH.

Mr. MOULTON, in replying on the whole case, said he began the case by stating that the plaintiffs accused the defendants, the Bradford Corporation, of using a meter in which there was a constant field, and in which permanent magnets used for the brake were powerful and constant according to that which the plaintiffs claimed in claim 3. The difference between his learned friends and himself on the third claim was one very much more of law than of fact. So far as fact went, his learned friends had never met the evidence of Mr. Dugald Clerk that the circuit on which this was to be put, was a circuit of practically constant potential, and the consequence of that was that the armature in this case was practically of constant strength. The defendants said that their instrument was designed to measure energy, and not to measure current, and even that when they used it under circumstances, where in fact it measured current, it could not come within the plaintiffs' patent, because it was used in circumstances which were different. But he would say further that the plaintiffs' instrument was constructed on purpose to be used under circumstances such as those of Bradford Corporation. There was a device mentioned in the plaintiffs' patent which they did not claim, because someone else had done it before, and that was the starting coil. That was a coil which would destroy the serviceability of a meter if it were put on any circuit of higher electromotive power. The plaintiffs worked their meter in a constant field, and they got it by permanent magnets. Supposing that Bradford worked their meters in a constant field, they might get it from any source. If they kept their mains constant, the pressure was constant, and they had not denied it, and so they had been taking a convenient source for a constant field. But how did a field obtained from those mains differ from one obtained from secondary batteries? But Bradford had used it as a constant field, and therefore had used it as a current meter; and with regard to the third claim, the Bradford people had obtained their effective brake by means of magnets of the type described in the plaintiffs' third claim. The case against the plaintiffs' was one of invalidity and non-infringement, and neither had been substantiated. In fact, in spite of three or four more years of searching and rooting about for fresh material, the present case was substantially the same as that which was tried before Mr. Justice Wills. So far as invention went, the combination of arrangement in the plaintiffs' specification was novel, and had not been published to the world in any way by anything which had been put before the Court now of date prior to Mr. Hookham's specification. Half a dozen people might have worked at the idea of trying to get a meter and failed, but the plaintiff had succeeded, and the fact that the magnets used by the plaintiffs had been used for other purposes did not tell the world that they were suitable for the purposes of meters. What the defendants had done here was, with present later knowledge, to take hints from Deprez that they could not have seen at the date of the publication of Deprez's paper. Dealing with the alleged anticipations, the learned counsel, referring to Marcel Deprez, said his paper was purely theoretical, and did not carry the matter further than Ayrton and Perry, except that he simply pointed out that fluid friction would not do. There was not a hint in Marcel Deprez to anybody that magnets of any particular form should be used. There was merely a general statement and reference to the magnetic speed indicator, or only a reference to the law of the current. Dealing with Siemens' specification, Mr. Moulton said that Siemens put his commutator at the ends of his magnets, which were neither permanent or powerful, and he had got a wrong idea of the law. Siemens was practically at the head of the electrical world at this date, and it was important to point out that he never saw the importance of these matters. Counsel stated he did not think it necessary to deal with the other alleged anticipations because it was idle to suggest that because a man found a magnet of a particular form which worked well in a telephone that that told the world how to make the brake of a thing which had got to work accurately and to measure quantity. Dealing with the plaintiffs' specification, counsel claimed that it was the first working out of a practical meter, rendered practical by two things, viz., a frictionless motor and a powerful and constant field. Mr. Hookham claimed the procuring of a powerful and constant magnetic field by permanent magnets arranged as described with the large polar surfaces closely fronting each other. He (Mr. Moulton) could find no anticipation of this method of the application of magnets of that kind to electricity meters in the papers before his Lordship. The question of the magnet being built up was not really the question in the case. The plaintiffs said to succeed you must have an extraordinary form of magnet, and without it you could not succeed. If that was so, and Mr. Hookham told the world how to succeed, that was a useful invention. Mr. Moulton submitted that defendants had clearly infringed the plaintiffs' third claim. People had produced magnets which they said were used before the date of the plaintiffs' specification. Taking the case of Abel's magnet, there was no suggestion how strongly he magnetised, and nobody suggested that Abel's was used with the large polar surfaces, having the function of the plaintiffs' polar surfaces. There was nothing in Abel to show that his magnets would be suitable for the brake of a meter, and there was no other magnet which counsel knew of which was like the magnet the plaintiffs described. Magnets like the one of Prof. Ayrton had been produced. As Prof. Ayrton's magnet existed, it would not be within the plaintiffs' description. What Prof. Aryton did was to add something to it in the course of the case so as to bring up one of the poles very close to the other. Supposing he produced a good field by such a magnet, the plaintiffs had no opportunity of testing the magnet or its permanency, or anything of the kind. That magnet was not what the defendants used. The defendants' magnet had got those flat pieces brought up very near to one another, and he submitted it came within the words, "large polar surfaces closely fronting each other, so as to form a narrow slit in which the brake revolves." He therefore contended that the defendants had infringed the plaintiffs' third claim.

At the conclusion of Mr. Moulton's address, his LORDSHIP said he would give judgment as soon as possible.

Judgment was accordingly reserved.

THE CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED, *v.* WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

THIS case came before Mr. Justice Farwell on Saturday and Monday last in the Chancery Division. It was an action which raised questions of considerable importance as to the construction of an agreement dated January 31st, 1870, entered into between the two companies.

Mr. Swinfen Eady, Q.C., Mr. Hughes, Q.C., and Mr. H. Green appeared for the plaintiffs; and Mr. Haldane, Q.C., Mr. Younger, Q.C., and Mr. A. F. Peterson for the defendants.

It appeared that the plaintiffs own several telegraph cables laid along the south coast of the island of Cuba and a landline across the western extremity of the island of Havana. Such cables thus connecting Havana with Santiago. From Havana, telegraph cables, which are owned by the International Ocean Company, run northwards to Florida, which is connected with landlines with New York. The defendants are the owners of telegraph cables running from Santiago to Jamaica, and to nearly all the other islands of the West Indies, and to Georgetown and to Colon on the Isthmus of Panama. By the agreement of January 31st, 1870, between the plaintiffs and a company of the same name as the defendant company, being the predecessor of the defendant company, it was provided as follows:—(1) "The Cuba Company will hand over to and forward by the West India Company all telegraphic messages received by or sent through the lines of the Cuba Company for any other part or parts of the world with which the West India Company may be in telegraphic communication. (3) The West India Company will hand over and forward by the Cuba Company all the telegraphic messages received by or sent through the West India Company for such places as the Cuba Company may be in telegraphic communication with. (4) Each company participating hereto will forward the traffic and messages received from the other company with all possible expedition, and in case of breakdown of line will repair the same as speedily as practicable, and generally will assist by every means in their power to develop the traffic and lines of the other company. (5) Neither company participating hereto will enter into any agreement or traffic arrangement with any other company or persons, or be connected with or interested in any telegraphic line whatsoever which may be prejudicial to the interests of the other company participating hereto without the assent in writing under the seal of such company being had and obtained. But either company shall be at liberty to send messages over their lines at the written request of the sender of such messages without solicitation or suggestion by any competing lines, provided that in such case the other company participating hereto shall share in the amount accruing in respect of such messages in proportion to the amount each company would have received had the messages gone over the lines of both companies. (7) The West India Company are to be at liberty to place all their wires and cables at Santiago de Cuba in connection with the wires and cables of the Cuba Company, and they are also to be at liberty by their own officers and servants to work all through traffic from any part of the West India system to any place or places beyond Havana without any interruption or interference by the Cuba Company, and the through traffic of the West India Company is to take precedence and have priority over all the local traffic of the Cuba Company, except as otherwise provided by the terms of the said concession. (8) The West India Company are to find, supply, and maintain the necessary staff at Santiago de Cuba for working not only their own lines, but also the Cuba lines, charging the Cuba Company a fair proportion of the cost of staff at Santiago de Cuba and the whole cost of staff at the intermediate station or stations, and an addition of 25 per cent. on such cost their share of the expenses of as general management and superintendence." The plaintiffs alleged that by means of the defendants' cables the plaintiffs are in telegraphic communication with all places directly served by the defendants' cables and with places beyond with which the defendants are in telegraphic communication, and further, that by means of the cables from Havana to Florida, and of the landlines to New York, and of submarine cables from New York across the Atlantic, all places directly served by the defendants' cables, and places beyond with which the defendants are in telegraphic communication with North America, and with London and other places in Europe. A new cable has recently been laid between Bermuda and Jamaica by the Direct West India Cable Company, and by such means, and the cables of companies allied with the Direct Company, the plaintiffs alleged that competition with the business of the plaintiffs and the defendants

was threatened. The plaintiffs charged that any such arrangement as the defendants threatened and intended to make with the Direct Company whereby messages handed in by the Direct Company at Jamaica would be transmitted by the defendants' lines to places South and East of Jamaica at a rate lower than that charged locally from Jamaica to such places would be an agreement or traffic arrangement prejudicial to the interests of the plaintiffs, and that any such arrangement would constitute a breach of Clause 5 of the agreement of January 31st, 1870. The plaintiffs claimed an injunction restraining the defendants from entering into an agreement or traffic arrangement with any company or persons which might be prejudicial to the interests of the plaintiffs without their assent in writing under seal; also an injunction restraining the defendants from forwarding any telegraphic messages received by the defendants at Jamaica from the Direct West India Cable Company for transmission to the East or South of Jamaica under an agreement or traffic arrangement which was or might be prejudicial to the interests of the plaintiffs, and for consequential relief and damages.

The defendants, by their statement of defence, said they had never threatened or intended, and did not now threaten or intend to arrange with the Direct Company to transmit messages from London handed by the Direct Company at Jamaica to the defendants for transmission to places south and east of Jamaica at a lower rate than the local rate to such places from Jamaica, or to arrange terms with the Direct Company which should enable the messages handed by the Direct Company to the defendants at a rate greater than the through rate which had been fixed with respect of messages from London to places south and east of Jamaica, *viâ* New York and Havana. The defendants had fixed the rate payable for messages transmitted over their lines, so that the through rate from London, *viâ* the Direct Company, to a place to the south or east of Jamaica, was, for the present, the same as the present through rate to the same place from London, *viâ* New York and Havana, but they had not done so under or by virtue of any arrangement or agreement with the Direct Company. They alleged that the plaintiffs claimed to do, and had for many years done, and were still doing the very thing which they now claimed the defendants were not entitled to do. In 1889 a French company, La Société Francaise des Telegraphie Sous-Marin, opened for public traffic a system of cables between Santiago de Cuba, Porto Palata, San Dominique, Curacoa and Venezuela, and in 1890 they opened cables between Martinique and Paramaribo. In 1891 they also laid a system of cables between Paramaribo, Cayenne and Vizen, and between Porto Plata and Martinique, and the French company's lines therefore connected Santiago de Cuba (the eastern extremity of the plaintiffs' system) with Martinique, Paramaribo, Cayenne and Vizen, and it became possible to send messages from and to New York and London over the plaintiffs' system. If the plaintiffs should prove successful, the defendants by way of counterclaim set out that the French company was in competition with the defendants, and the agreement or arrangement between the plaintiffs and the French company was prejudicial to the interests of the defendants, and was a breach of the agreement of January 31st, 1870. They claimed that by reason of such acts the defendants had suffered great damage and they counterclaimed an injunction restraining the plaintiffs from handing to the French company at Santiago de Cuba any telegraphic messages sent over the plaintiffs' lines for transmission to Cayenne or Vizen, or any place south of Martinique, except such messages as the sender thereof, without solicitation or suggestion, should in writing request the plaintiffs to forward by way of the lines of the French company. They also asked for a declaration that the defendants were entitled to a share in the amount of toll accruing to the plaintiffs with respect of messages sent over the lines of the plaintiffs and handed by them to the French company at Santiago de Cuba for transmission to Cayenne or Vizen, or places south of Martinique, which the sender might request the plaintiffs to forward by way of the lines of the French company. By way of further relief the defendants claimed an injunction restraining the plaintiffs from entering into or continuing any agreement or traffic arrangement with the French company, or any other company or persons which might be prejudicial to the interests of the defendants without their consent in writing.

After hearing lengthy arguments by the learned counsel on both sides, Mr. Justice FARWELL in giving judgment, held that the plaintiffs were entitled to succeed, but left the form of the declaration to be settled by counsel. He thought that the interpretation put on the agreement by the defendants was much too narrow, and would lead to ridiculous results. He thought it was clear that the plaintiffs lines had been intended as a connecting link between the International Ocean Company and the defendants' lines. The general idea was a connection of the West Indian Islands with North America; competition was the keynote of the agreement, and the parties plainly intended that there should not be competition between either of the companies or any other company. His Lordship accordingly gave judgment for the plaintiffs, and ordered that the costs should follow the event.

Mr. Haldane applied for a stay of execution for 14 days, with the view to the defendants appealing, and his Lordship granted the application.

THE CASTNER KELLNER ALKALI COMPANY v. THE COMMERCIAL DEVELOPMENT CORPORATION.

(*Concluded from page* 823)

THE further hearing of the appeal, the Castner-Kellner Alkali Company, Limited, against the Commercial Development Corporation, Limited, was resumed in the House of Lords on Thursday last week.

Mr. BOUSFIELD was heard on behalf of the appellants. He said there were three great questions at issue. The respondents alleged that the specifications were imperfect, insufficient, ambiguous, and misleading. That was the first question, and it gave rise to the second, the question of nonconformity, and third, there was a question of infringement. The Master of the Rolls said the real nature of the appellants' invention was an apparatus for moving an open-mouthed vessel containing an electrical solution of salt over a stationary layer of mercury covered with fresh water. "The vessel," he pointed out, "is to be moved in such a way that the electrified salt solution shall be in contact with part of the mercury for a time and then be shifted to another part while the mercury first acted upon by the salt water and converted into an amalgam of mercury and sodium shall be brought into contact with the fresh water so as to decompose the amalgam into mercury and soda in solution." The evidence of the respondents bore that out, and if that was a correct description of the appellants' patent, the appellants were entitled to succeed in this appeal. The learned counsel then produced models showing the methods of carrying out the invention. In the case of the respondents the cells were circular, but if they took the cells in the appellants' apparatus and turned them into circular cells, it was clear they made a more immaterial change. So far the respondents were simply carrying out the invention described by the Master of the Rolls as the invention of the appellants. Further, if the respondents took the appellants' invention, and, to escape infringement, said, "we have discovered a very ingenious arrangement by which we will fix the cells and slowly move the dish round," would not that be regarded as a mere modification of the appellants' invention? As to the question of specification, the learned counsel quoted a case in which it had been laid down that a patentee was not prevented from improving the means of carrying out the invention for which he obtained protection, the only limit being that the invention as finally specified must not be a different invention from that provisionally protected. He was not to be bound down to the methods shown in the provisional specification, and their Lordships had acted upon that in subsequent cases. The learned counsel then dealt with the statement of the Master of the Rolls that the inventions were different, because in one the mercury was not kept as still as possible, but was disturbed, which was quite inconsistent with the original idea. In that he contended that the Master of the Rolls had been somewhat misled, and he quoted from the evidence to show that there must be some little local eddying, but there was no more agitation than was necessary from the cells dipping in the mercury. Lord Kelvin's evidence, in answer to questions, was that in Rhodin's apparatus the vessel containing the mercury was stationary; the mercury was as nearly stationary as it could be got by the mechanism; these were to disturb the mercury and make it move the lips of the tubes; and as to the mercury being stationary, he could not distinguish between the apparatus of the appellants' and that of the respondents. That was the whole of the appellants case. Some of the witnesses put forward the theory that there was difference, because with Rhodin's system the mercury was to be stirred up. In the rapidity of movement and agitation a distinction was attempted to be set up between the invention of appellants and that of the respondents, but the learned counsel, by analysing the specification of the Rhodin patent, maintained that such distinction could not be upheld.

Mr. TEBBELL then addressed their Lordships on behalf of the respondents. He dealt first with the smallness of the area of the invention which was said to be infringed, pointing out that he had pressed witnesses to say what was done by the Kellner patent which had not been done by other patents previously, and the most that was said for it was, that by it a smaller quantity of mercury was required for the operation. There were three questions which he submitted to their Lordships. First, the respondents said that the principle introduced in the final specification of the Kellner patent was not merely a departure from the provisional specification, but was absolutely a contradiction of it. Secondly, for the very reason if the appellants were right in saying that the modification was not a contradiction of what contained in their provisional, the respondents did not infringe the appellants' patent. Thirdly, the respondents said there was not subject matter for this invention in their evidence, according to the requirements of patent law. Counsel then described in detail Kellner's invention and several others which preceded it, finally describing the Rhodin patent. Contrasting the respective specifications, he maintained that if the respondents infringed it was because there was disconformity in appellants' specifications, and if there was no disconformity, then the respondents did not infringe. A model of the Rhodin apparatus was at this stage brought into the House, and the mercury having been poured into it from a stone jar, a representative of the respondents' company showed the invention in operation, their Lordships standing round the model, which had been placed on the Lord Chancellor's table. Thereafter the learned counsel resumed his address, proceeding, after he had dealt with the distinctive features of the Rhodin process, to discuss the question of the subject matter of an invention. Subject matter for a patent, he said, involved utility.

The LORD CHANCELLOR said the word "utility" did not appear in the statute, and in no case had the word been interpreted in the sense in which the learned counsel used it. Of course a mere idea which was not capable of being applied, could not be patented.

Mr. TEBBELL said, of course, there must be invention. There must be the exercise of the inventive faculty, and the invention must do something. It must accomplish some purpose. In this case the appellants must show that their patent accomplished something, and they could not show that it accomplished anything which the original method of using mercury did not equally perform. He maintained that reading Rhodin's specification and taking it as he was entitled to do, as a description of what the respondents proposed to do, there was no evidence that the respondents using Rhodin's process must of necessity infringe the appellants' patent.

Mr. Astbury followed on the same side, and their Lordships afterwards adjourned till Monday morning.

In the House of Lords on Monday the hearing was resumed. Mr. Astbury, in continuing his argument for the Commercial Development Corporation, of Liverpool, contended that in the Rhodin apparatus there were ribs at the bottom which were absent in that of the appellants, and without which the Rhodin apparatus would not work. In Kellner's arrangement, as was stated by Mr. Dugald Clerk, they must have one cell in the path of the other—the combining cells must be in the path of the decomposing cell—while in the Rhodin the combining chamber was out of the path of the decomposing cells altogether. Counsel also argued that there was a difference as to the relative areas of water and mercury in the different processes, as stated by the witness.

The Lord Chancellor said it seemed to him that neither side knew how their apparatus really would work, and the witnesses had to speak from theory.

Mr. Astbury said his clients knew that their system would work. Theirs was a thoroughly efficient system.

The Lord Chancellor: But so far as the last matter you mentioned is concerned, you have not tried by experiment.

Mr. Astbury: That is so far, but so far as our system is concerned we have got the matter ready for work. We have bought the patent and have spent a large sum of money upon it. Counsel, proceeding, argued that the appellants patents were a mere paper invention, which they did not even work, and they had not even shown that it could be worked. The first patent of the appellants was of a very limited nature. It was an apparatus for carrying out a well-known process. Unless they could show that they had produced the results in a better and more advantageous way, it was a question whether there was the subject matter for a patent in the specification. But assuming there was a patent in that No. 1 Specification of Kellner, the only thing that made it an invention was the difference between it and that of Castner. But when Kellner came to his complete specification, he particularised and made a claim for that very thing—the difference between his invention and the earlier invention, which difference was the only ground for his invention. He had, in a word, gone back on his final specification upon that which was the only thing which differentiates his invention from that of the Castner. Kellner, in fact, did what Castner did, but in a very inefficient manner. As to infringement, there were seven elementary differences between the appellants' and respondents' processes. Counsel, in conclusion, said he had a number of authorities, but he did not think it was necessary to quote them.

The Lord Chancellor said there would be no need to quote authorities, for there was no principle of law disputed.

Mr. Fletcher Moulton then replied for the appellants. He reminded their Lordships that the plaintiffs in the action were the first to propose the electrolysis of the cells by means of mercury. He put it that the case for the defendants was that that was the only process they used. He quite agreed that in the attempt to use that particular method of working they got a certain amount of agitation which was inseparable from the process. He hoped to show their Lordships that the respondents used precisely the same means, and he should say used substantially the same patent. In the case of the defendants it was admitted that the mercury was held in a vessel which was not moved, and that it had ribs or partitions on purpose to keep the mercury still. So they had got this, that the respondents' invention in this respect, that they took a stationary mercury cathode in which the mercury lies quiescent and is prevented moving by reason of these ribs. So they had got in both inventions an apparatus which was designed to keep the mercury stationary. They had got cells which just dipped into the mercury, and that part within them got charged with sodium; then, as it rotated, the cell parts got uncovered and exposed, and the water was decomposed, and so the thing went. The respondents had taken a stationary cathode and made the mercury go through the office of charging and discharging by moving the partition on the surface of the mercury. Except that it was done by moving it round, whereas the appellants originally spoke of the process as moving to and fro, this was precisely the operation described in the appellants' specification. The rotary motion had exactly the same effect as the to and fro motion. One could not patent a particular method of using a thing. A man might patent an instrument or a process, but the instrument being patented a man could not patent a particular method of using it. A man having patented an instrument had a right to work it quickly or slowly. The instrument was what was claimed in the patent, and the respondents could not get out of it by saying they might use it quickly or slowly. The learned counsel then proceeded to deal with the allegation of non-utility, calling special attention to the evidence of Lord Kelvin that appellants' process was the better of the two, and to the admission of Mr. D. Clerk, to whose evidence reference had already been made, that he could well imagine circumstances under which each of the two systems might be the better alternative to adopt.

Their Lordships announced that they would consider their decision.

Ashwell & Nesbit, Limited, *v.* Stanton.

In the Queen's Bench Division on Monday before Justices Darling and Bucknill, the case of Ashwell & Nesbit, Limited, *v.* Stanton was heard on appeal by the defendant from a decision of the Official Referee. Mr. Manisty, who appeared in support of the appeal, said the action was one brought by Ashwell & Nesbit, Limited, electrical engineers, of London and Leicester, against Mrs. Stanton, a retail boot and shoe factor, of Leeds, to recover £500, the balance of an account for an installation of electric light. The defendant had filed a counterclaim on which she claimed damages for non-fulfilment of contract to have the installation completed by a certain date. Learned counsel said that the defendant, Mrs. Stanton, was about to open new premises in Leeds for the purposes of a boot and shoe business. She was desirous of having the building lit by electricity, and she entered into a contract with the plaintiffs to do the work. By the original contract no actual time was fixed for completion of the work which was to be carried out in an expeditious and workmanlike manner. During the progress of the work Mrs. Stanton was naturally anxious to have a date given her which would be a guide to her as to the time she might advertise the opening of the premises, and she accordingly had an interview with Mr. Lunn, who was in charge of the work. That was in October, 1897, and Mr. Lunn said she could have the light on October 30th. The defendant asked Lunn if he was quite sure, and he replied that he could give her an absolute assurance; but in order to guard against any possible delay, she said she would give him until November 5th. Lunn said the defendant might rely upon him completely. Mrs. Stanton thereupon advertised the opening of the premises, and engaged assistants, but on the date announced she was unable to get any light, and thereby incurred considerable expense. The matters in dispute came before the Official Referee, and the plaintiffs then took the point that although the assurance was given with the knowledge that it was intended to be acted upon, that the promise was a mere naked one, and was without consideration. The Official Referee came to the conclusion that the promise was not an absolute one, and that the plaintiffs could not be made responsible for the delay which had occurred in connection with the fitting of the gas engine which was to supply the motive power. The defendant then appealed to the Divisional Court, which held that the assurance was absolute and binding, but on the point that the promise was without consideration they thought there should be further arguments. Mr. Justice Wills, one of the judges then sitting, was taken ill before judgment was given on that point, and the matter now came before their Lordships on that point.

Mr. Justice Darling thought that want of consideration being raised, they had better hear the other side.

Mr. Pollock, for the plaintiffs, said that the whole difficulty arose by the breakdown of the gas engine. In fact, on the date mentioned the light was turned on for a short time. The plaintiffs had for some time previously maintained that they would not be responsible for the gas engine, which was not supplied by them, but by Messrs. Crossley. His point briefly was, that there was no consideration coming to him which would make the contract binding in this case.

Without calling upon Mr. Manisty to reply, Mr. Justice Darling considered that by the promise given, the defendants came distinctly within the rule which made it in the eye of the Court of Equity a real binding contract made upon good consideration. Therefore he thought that upon this point, which was reserved by the other divisional court, there should be judgment for the defendant with costs. The case would go back to the Official Referee to enable him to ascertain the amount of damages sustained by Mrs. Stanton.

Mr. Pollock asked for, and obtained leave to appeal.

BILLS BEFORE PARLIAMENTARY COMMITTEES.

Southport and Lytham Tramroad Bill.

On Friday, Monday, Tuesday and Wednesday last week, a Select Committee of the House of Commons, presided over by Mr. C. Seale Hayne, considered the above Bill by which the Southport and District Tramroad Company sought power to construct an electric tramway from Southport along the coast about 5 miles, where it was proposed to cross the estuary of the River Ribble by means of a conveyor bridge, thence to Lytham.

Mr. Ram, Q.C., who represented the promoters, said that last year a Bill was before the House to construct the tramway, but now it was proposed to cross the Ribble higher up the estuary. At present Blackpool, St. Anne's and Lytham, were connected by tramways, and last year Parliament sanctioned the construction of a tramway from Southport to North Meols, whence it was then proposed to make a tramway on the surface of the sand to the estuary of the Ribble and across the river to Lytham, and had the Bill passed, Southport and places immediately to the north of that borough would have been joined to Lytham, St. Anne's, and Blackpool by tramway. By the present scheme the tramway could be continued between 3 and 4 miles further along the coast from North Meols to Guides House, where the conveyor bridge would be constructed across the Ribble. The height of the bridge would be 147 feet, and the tramcar would be carried across the river by means of a suspended travelling cradle. He contended that there was no possibility of any of the proposed works damaging the navigation of the Ribble.

A great deal of evidence having been called in favour of the scheme from those living in the locality,

Mr. J. T. Wood, one of the engineers for the scheme, said the piers of the bridge would not interfere with the navigation of the river. The cradle of the bridge would be from 50 feet to 60 feet long, capable of carrying an electric car and trailer. About a minute and a half would be occupied in traversing the channel, and there would be duplicate machinery in case of accident.

Evidence was then called by the Preston Corporation, who opposed the Bill on the ground that it would interfere with the navigation of the channel.

On Wednesday an arrangement was come to, by which the pro-

moters promised to make the girders of the bridge 177 feet high, and thereupon opposition was withdrawn, and the Committee found the preamble proved and ordered the Bill to be reported to the House.

City of London Electric Lighting Bill.

On Wednesday last week the Select Committee of the House of Commons, presided over by Mr. A. H. Brown, considered the Bill promoted by the City of London Electric Lighting Company.

Mr. Balfour Browne, Q.C., who represented the promoters, said that the object of the Bill was to empower the company to apply to the purposes of their undertaking various reserve funds and to take lands at Southwark for the erection and extension of a generating station. The City of London Company was authorised under certain provisional orders to supply electricity within the City, and at the time they were authorised agreements were come to with the Commissioners of Sewers, which body acted then for the City of London, in which in return for the exclusive right of supplying electricity within the City the company accepted certain onerous obligations. One obligation was that the reserve funds should be invested in what were known as gilt-edged securities, and this precluded the company from investing this reserve in their own business as was the case with other companies. The reserve funds now amounted to £135,283 7s. 6d., on which the company was practically getting nothing. As the Corporation had allowed the Charing Cross and Strand Electric Supply Company to come into the City, the City of London Company now asked that they might be relieved of the onerous obligation of investing their reserve in gilt-edged securities, but to apply them in the manner they thought fit. By this means they would be placed in the same position as the competing company, and would be able to supply to the public more cheaply. The other powers asked for by the company were in respect of the extension of the generating station at Southwark, where they sought to acquire lands for that purpose and also for the erection of working-class dwellings for the accommodation of those engaged in the works.

Evidence having been called to bear out counsel's statement,

The Chairman said that the Committee found the preamble of the Bill proved, but would limit the application of the reserve funds in question to capital purposes and not allow them to be applied to dividend.

The clauses were then considered, and the Committee refused a clause proposed by the Corporation of the City of London restricting the company's charges to those authorised in the case of the Charing Cross and Strand Company. They inserted, however, a clause giving the Corporation power to purchase mains outside the City, but necessary to the supply of electric light in the City of London.

The Tyneside and County of Durham Electric Power Schemes.

(*Continued from page* 826.)

On further consideration of the Bill by the Select Committee on Wednesday last week, Alderman Wardell, of South Shields, was called, and said that the Corporation of that town had chosen a site for their generating station with the idea of supplying power to manufacturers, and had paid more for that site than they might have acquired another site for.

In cross-examination Witness said that the Corporation's was a single-phase system, which was not the best system to adopt for motive power.

Mr. J. A. Jeckell, electrical engineer to the Corporation of South Shields, said that he advised the Corporation with regard to the system of supply inaugurated under the Electric Lighting Order. The site of the generating station was in the centre of the town, where they could get a plentiful supply of water and had also facilities for obtaining a cheap supply of coal. When he advised the adoption of the single-phase system there were three systems in use, namely, the low tension continuous current; the high tension continuous current; and the single-phase alternating current. At that time the Board of Trade had not raised the pressure of low continuous distribution, although they eventually doubled it. A high tension direct current system would have required twice as much capital as the single-phase system. If a demand arose for current in the district they could increase the load factor, which was not very good now. The system of charge adopted by South Shields was equitable to all consumers. The system of the Corporation had paid, and would fetch a much larger price now than it cost the Corporation to inaugurate. At present 1,450 E.H.P. was available at the station, but by the end of August they hoped to have 2,500 H.P.

Replying to Colonel Long as to the lowest price at which the Corporation could supply electricity, Witness said that taking an ordinary factory working 10 hours a day and doing an ordinary fairly level amount of work, he thought they could supply somewhere between ¾d. and 1¾d. per unit.

The Chairman asked witness whether, in his opinion, it would be a hardship if the Committee said that for power purposes the maximum the company were allowed to charge for their first 100 hours must be 2d. under the sliding scale.

Witness said that would depend on what the second 100 hours were going to be. He did not think it would be a hardship to fix 2d., because the lower the price the sooner people would take it up, and the sooner would they be recouped in that way.

Evidence having been called showing the liabilities of South Shields,

Mr. Hans Hamilton addressed the Committee for the South Shields Corporation, and contended that it would be unfair to allow competition in a district already adequately served. At the same time, if the Tyneside Company were willing to supply the Corporation in bulk without competing with them, they would be welcomed. Speaking on behalf of the Jarrow Corporation, Mr. Hamilton said that this Corporation had consented to the electric supply being granted to the County of Durham Electric Power Distribution Company, which company was able to distribute every kind of power. The Corporation had very carefully considered the Tyneside Electric Power Bill and the County of Durham Electric Power Supply Bill, and had satisfied themselves that the Durham Company would be able to meet all the demands, present and future, in Jarrow, for all purposes, and had satisfied themselves that this company was financially strong enough to carry out their undertaking. The Corporation also agreed with Lord Kelvin that it was not an economic arrangement to have two companies in a district cutting up the streets.

Mr. Moon addressed the Committee on behalf of the Durham Electric Power Distribution Company. He pointed out that the company had a provisional order to supply Gateshead, but the concession was limited to 13 years, at the end of which term the Corporation would have the option of purchasing the undertaking as a going concern. They had also been granted a provisional order to supply Jarrow, although in this case the period of concession was limited to eight years when the Corporation would have power to purchase as a going concern. As regards Whickham, they had an arrangement by which the local authority consented to their application for a provisional order. The main objection of his company was to the competition which the scheme introduced. If power was given to supply by wayleaves, it would be easy for the Tyneside Company to supply manufacturers in the districts in which his company had the right of supply. They could not only get wayleaves along the North-Eastern Railway, and also get along the line and through the colliery sidings so as to supply manufacturers within the district in bulk. The Bill authorised supply with the consent of the local authority, and if passed as it at present stood competition might be introduced not as the decision of Parliament, but as a matter of electioneering tactics. Then again this was an aggregation of manufacturers to supply themselves, and they would not be limited to a certain number of years like his company was under the Electric Lighting Act, and consequently had not to put by money as a sinking fund. He contended that unless the power companies could show that the distributing companies had not properly performed their duties, no competition should be allowed. The Tyneside Company merely said they might supply more cheaply, and his contention was that they had not proved anything of the kind.

Mr. Fitzgerald, for the Walker & Wallsend Gas Company, which secured a provisional order last year to supply Walker, Wallsend and Willington Quay with electric light, next addressed the Committee, and said that nine-tenths of the manufacturers of the district petitioned in favour of that order. They could supply electric power as cheaply as the Tyneside Company, but if the present Bill was authorised his company would be placed in a different position to what was intended by the Legislature. If they got two companies in a district, the load factor of each would be reduced, with the result that ultimately the public would suffer. He submitted that his company which, on the strength of their order obtained from Parliament, was spending £150,000, ought not to be interfered with.

Mr. C. Merz was called, and said he had been retained by the Walker & Wallsend Gas Company as regarded their electrical proposals. He agreed that economy depended on having a large generating station. It should be 5,000 H.P., or otherwise they could not get the greatest economy. Most of the manufacturers in the district had asked the company to lay out their installations, while others had laid out their own. He thought the amount of power which would be required had been somewhat exaggerated by the promoters. With the arrangements they had already made, his company would be in a position to more quickly meet any demands made than any other company coming in, and he saw no benefit which would accrue by the Tyneside Company coming in. It would not be economical to transmit energy throughout the whole of the proposed district for one generating station, as the loss on transmission would more than counterbalance economy in generation. The Walker & Wallsend Gas Company were putting up a station capable of supplying 5,000 H.P., and anticipated being able to start supplying in August. They had paid special attention to the requirements of manufacturers, and could supply direct current and polyphase current. They hoped eventually to bring their charge down to a manufacturer to 1d. per unit.

The Committee adjourned.

At the sitting of the Committee on Thursday last week the evidence of Mr. Merz, the electrical adviser to the Walker and Wallsend Gas Company, was continued. Witness said that if competition doubled or increased the capital invested in the manufacture of electricity in a district it necessarily increased the price which must be charged to the consumer. With regard to the proposed charges of the Tyneside Company for motive power, the charges of his company compared most favourably with them. Further, his company was in a position to supply at once, whereas the Tyneside Company would not be in a position to supply for two years at least. The Walker and Wallsend Company were the pioneers of electricity in the district, and seeing that they had raised their capital and obtained their Act, he did not think the Tyneside Company should be allowed to come in. If, of course, the company failed to carry out what it had undertaken competition should be allowed.

Mr. Summers Huster, manager of the North-Eastern Marine Engineering Company, Wallsend, and a number of other gentlemen with large commercial interests in the district served by the Walker and Wallsend Company, stated that satisfactory arrangements had

been entered into with the company to supply them with motive power, and they saw no reason why competition should be allowed. No large manufacturers, with the exception of the actual promoters of the Tyneside Company, supported the Bill.

Mr. S. T. HARRISON, chairman of Wallsend District Council, said the Council last year supported the application of the Walker and Wallsend Gas Company for electric lighting powers. The company had pushed forward their works well. The directors of the company were men of substance, and they had every confidence in their ability to carry out their undertaking. The Council had carefully considered the proposed competition, and having regard to the agreements which the Council had carried out with the company, they did not consider it advisable that the Tyneside Company should be allowed to come in.

Mr. WILSON CARR, consulting electrical engineer of Newcastle-on-Tyne, said no question had been directed to the economic application of electricity for motor purposes. He was electrical adviser to North-Eastern Marine Engineering Company, which company had made an arrangement for a supply of 700 H.P. with the Walker and Wallsend Company. He approved of the system the company had adopted, and thought it was a system for which electricity could be most economically supplied. If another company came in, the cost of the double plant would cause prices to be increased eventually. The ability of a large manufacturer to put down his own plant, he considered, sufficient competition.

In cross-examination, WITNESS said that under present conditions, he did not consider there was a field for two companies.

Mr. CHARLES HOPKINSON, M.I.C.E., said he agreed in substance with what had been stated by Mr. MERZ. He pointed out that by the Bill the company would have a free hand to charge people what they liked, and the public could not demand equal treatment.

Mr. RICKARDS next recalled Mr. MERZ, to give evidence on behalf of the Newcastle Electric Supply Company, and said the present generating station of that company was unsuitable for their extending business, and they had scheduled another site in the Wallsend district. The selected site was by far the best site for the intended purpose. The Tyneside Company wanted that site but the Newcastle Company could supply more quickly.

Mr. RICKARDS explained to the Committee that the Newcastle Company was the first in the field for the site, but the Tyneside Company forestalled them.

In cross-examination, WITNESS admitted that the Newcastle Company had scheduled three sites in their Bill, but the site in question was the pick of the three. He was not aware that the owners had agreed to sell the site to the Tyneside Company.

Dr. JOHN THEODORE MERZ, vice-chairman of the Newcastle-on-Tyne Electric Supply Company, said the company had already raised on shares and loans £125,000 and that had all been spent. The capital had now been increased to £300,000 and £200,000 had been allotted. In 1891 they obtained an order to supply electrical energy to the whole of the City and County of Newcastle. The Newcastle and District Electric Lighting Company secured a similar order at the same time, but to save the streets being broken up by both companies an agreement was drawn up with the consent of the local authority by which the district was divided up between the two companies. They were both able and willing to meet all demands made upon them in the district and objected to the Tyneside Company coming in. The solicitor of the company entered into negotiation in February, 1898, for the acquisition of the new site which had been referred to, and it was scheduled before they knew that the Tyneside Company had scheduled it. They could not acquire the site as they had no power to before coming to Parliament. They had come to an agreement with Walker to carry out their undertaking under the provisional order for 10 years, and they had come to a further agreement with the Walker and Wallsend Gas Company to supply them in bulk, the gas company being their own distributors. They had powers to supply Long Benton and were applying for powers to supply Gosforth. He was satisfied that they would be able to supply electricity for all purposes on more favourable terms than any other company.

The Committee adjourned.

On Friday, last week, Mr. J. S. WATSON, engineer of the Newcastle-on-Tyne Electric Supply Company, stated that his company had supplied electric energy for 12 years, and two years ago they adopted the continuous current system. The company was prepared to supply manufacturers with the whole of their electrical equipment without initial cost to them, and they were now laying cables capable of dealing with any amount of power which would be required in the city. The maximum prices they proposed to charge were 4d. per unit for the first hour's use per day, and 1d. for the second hour, but all manufacturers knew they would be supplied lower than that.

In cross-examination, WITNESS admitted that these charges were not in the provisional order, nor had they sent out a circular to that effect, but they had negotiated with manufacturers on that basis. The rates had not been lowered to meet the Tyneside Bill.

Mr. ROBT. HAMMOND, M.I.E.E., said he was for years the pioneer of the system of one large generating station for the supply of a large district. From an analysis he had made of the Board of Trade returns respecting the cost of production in all leading electric lighting works, he found that in most cases the load factors were low. The prices proposed to be charged by the Newcastle Supply Company compared most favourably with those proposed to be charged by the Tyneside Company. He considered that the Newcastle Company, in its present area, could produce electricity more cheaply than the Tyneside Company could in their proposed district. There was a point in the enlargement of works at which the limit of economy was reached, and he put the figure of economy at between 5,000 and 10,000 KW.

Mr. ASHCROFT (a member of the committee): It appears to me that in the case of small local authorities, who would not think it desirable to put up generating stations of their own, that it would be an advantage if they had two sources of supply in bulk to choose from. Do you see any objection to that?—I think the objection is that there is double capital involved.

Replying further to Mr. ASHCROFT, WITNESS said that probably as the use of electricity increased for power purposes the load cost would be largely decreased. In the London orders the charges were all made subject to revision by the Board of Trade at the end of seven years.

Prof. AYRTON said he had considered the Bills of the Tyneside Company, the County of Durham Company, and the Newcastle Company. He considered the Newcastle Company's prices compared most favourably with the proposed charges of the Tyneside Company, and he considered that the arrangement adopted by the Newcastle Company of the maximum rate was a good one. If he had the offer of supplying the area mapped out by the Tyneside Company for one station, he would prefer to supply that portion mapped out by the Newcastle Company, which was about a quarter of the size of the whole area. He did not think the area mapped out by the Tyneside promoters North of the Tyne could be economically supplied by one station. Experience had shown that in London it was the companies supplying the small compact district that paid the dividends, as against the scheme to supply a large district from Deptford.

Mr. PEMBER then addressed the Committee on behalf of the Newcastle Supply Company. He said that the company was bound to find a new generating station, but their Bill was in no sense put forward as an answer to the Tyneside Bill, and they had fixed on the site before the Tyneside Company was hatched. Other things being equal, he thought the Newcastle Company had a right to the consideration of Parliament. His company was an old company which had carried out its obligations, while the Tyneside Company was a new concern which offered no new advantage, and which was not welcomed by the local authorities. He asked if it was a good precedent that a company should be allowed to come in and choose a district and avoid all the consequences under the Electric Lighting Acts.

Mr. BAGGALLAY replied for the promoters of the Tyneside Bill, and said that the point of principle which would have to be decided between the company and the local authorities was whether it was for the public interest that a local authority should be able to say to the manufacturer, "You shall purchase something which is essential to your business in a market prescribed by us or you shall not purchase it at all." He ventured to say that it would be prejudicial to trade if the Committee held that the local authorities should have such power. The question of the Newcastle Company's Bill ought not to come in at all because the Bill was not yet before Committee, and it would have to be shaped by what that Committee decided with respect to the Bills they were now considering.

The Committee adjourned till Wednesday.

MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

(*Continued from page* 825.)

ON Thursday last week Mr. BEHR was recalled, and was asked whether it would be possible to carry the railway through Salford in a tunnel.

WITNESS said that unless the tunnel was of an enormous sectional area, they could not reach the speed they desired, and he did not think that the public would care to travel through a tunnel at the speed they desired to go. Besides that, it would cost three times as much as the viaduct.

Mr. FREEMAN, Q.C., addressed the Committee on behalf of the Salford Corporation in opposition to the Bill, and contended that the railway was not needed by the public. The line was quite of an experimental character, and the evidence adduced showed that the whole of the elements counted upon for success were extremely problematical.

Mr. LITTLER, Q.C., followed on behalf of the Cheshire lines, and contended that the scheme was not only a very novel one, but an exceedingly complex one, and the history of inventions showed that a very complicated system was not likely to be successful. Not one of the witnesses, he said, could say from practical experience that the enormous speed suggested could be attained with safety; all they said was that in theory the line could be worked as suggested. He contended that under the Bill, if the promoters found that the public did not come forward to subscribe the capital for the monorail scheme, they would be enabled to start the line as an ordinary railway and compete with the existing lines. He appealed to the Committee not to sanction such a dangerous experiment as this railway would be, seeing that the advantage to the public was of a very doubtful character.

On Friday the Committee were occupied with hearing further evidence from railway interests in opposition to the Bill.

Mr. STEEL, the manager of the Great Northern Railway, said he did not believe the public would patronise the railway even if it were constructed, for nobody wanted to travel at 110 miles an hour. He did not believe the scheme would ever prove a success financially, while it would injure existing railways in the district.

Mr. TURNER gave similar evidence on behalf of the Midland Railway, of which he is the manager.

Sir DOUGLAS FOX, consulting engineer to the Cheshire Lines Committee, said he would not seek to obtain high speed on a monorail, but he believed that high speed would be obtained on ordinary railways by electricity, which, no doubt, was to be the motive power of the future. He regarded the proposed construction of the carriages

as a very complicated arrangement. The question of the brake power was a very serious one, and the fact that there would be no means of communication between the two rails in case of accident was a great drawback.

Cross-examined, the WITNESS said he did not admit that the question of monorail working had anything in common with the question of working by electricity. He was not aware that at the present time there was a train running in America at the rate of 110 miles an hour.

On Tuesday, the chairman of the Committee, Sir JOHN KENNAWAY, said that they had heard with great interest the evidence laid before them. It appeared to them that the monorail system which was suggested for the proposed railway was likely, when fully matured, to make an important contribution to the development of railway traffic at high speed. In certain important respects, however, the present scheme was seriously incomplete. More particularly the evidence had not satisfied them that a safe method had yet been made of effectively applying brake power to trains running at the high rate of speed proposed. Apart, however, from such considerations, the Committee were of opinion that the proposed line had been laid out without adequate and reasonable regard to existing interests, bearing in mind that the intermediate districts did not participate in any of the advantages of the railway. The Corporation of Salford would seem to have just ground for complaint in respect of the interference of the proposed line, and the use of land at Liverpool required by the Mersey Docks and Harbour Board for the construction of additional docks had weighed seriously with the Committee. The Committee were of opinion that in all schemes put forward for giving further railway access to the heart of great cities the question of underground approach ought to be considered and adopted where practicable. On these grounds the Committee were of opinion that the preamble of the Bill was not proved.

MUNICIPAL TRADING.

ON Tuesday last the Earl of Crewe presided at the Joint Parliamentary Committee of both Houses, when

Sir COURTENAY BOYLE gave evidence as to municipal enterprise with respect to tramways, gas and water. He said that whilst as to these Parliament interposed no difficulty, electric lighting was on a somewhat different footing. The Act of 1888 contemplated competition, and the practice of the Board of Trade was to allow competition between two bodies of traders or two undertakings—not more. With regard to gas, a local authority could not extend the supply beyond its own area without the sanction of Parliament, or even within that area if it was already supplied by an independent company. The general legislative powers with regard to gas had been largely taken advantage of by Corporations. Private companies were nearly always incorporated by special Act. In the United Kingdom he believed there were 222 authorised gas undertakings belonging to local authorities, which yielded a gross profit of £1,181,675, equivalent to 6 3 per cent. upon the capital. The policy of Parliament had been to allow local authorities to purchase existing gas undertakings but not to compete against them. The number of electric installations authorised was about 300. Powers which were in the early days granted to many authorities had not been put in force. About 99 installations were now at work. Some municipalities had the power to supply electric current outside their own areas. This power was either given direct by Parliament or it had been acquired by the absorption of powers possessed by others. There were several instances of this transfer of powers. In some Parliament had authorised the supply of electricity in bulk to outside districts. As a rule, however, the Board of Trade endeavoured to confine a concession asked for to a given geographical area. He was unaware of any instance where a forcible transfer had been permitted. The grant to a local authority of power to supply outside its district naturally made that authority a trading authority in the outside districts. If it lost, the municipal ratepayers lost to benefit the outside district; if it gained, the municipal ratepayers gained at the cost of the outside authority. He could offer no opinion as to whether or not it was a right policy.

Lord ROTHSCHILD: Would you under these circumstances allow a sliding scale?—It would be rather difficult.

Sir COURTENAY BOYLE added that with respect to electric lighting, there had been applications made for power to supply fittings. The Board of Trade had always objected to corporations being allowed to make or sell fittings. If the supply of these things was necessarily incidental to the supply of electricity, it might however be permitted, but not otherwise. For instance, the provision of a good supply meter (when one was found) might very well be entrusted to corporations; but not, he thought, burners or things of that sort. The wiring of houses for electric lighting had not been entrusted to corporations.

In reply to Mr. LEWIS FRY, WITNESS said that the thing supplied was electric energy, which might be used for lighting, motive power, or any other purpose. Its use was not limited either by statute or otherwise.

In answer to the CHAIRMAN, Sir COURTENAY BOYLE stated that as to the tramways there had been a distinct progress in the policy of Parliament. In some cases authorities had joined in the promotion of a tramway undertaking. It was worth consideration whether such an arrangement would not be more satisfactory than one by which a municipal authority went outside its area to trade as a company. Tramways might in such cases be worked by joint boards. The tendency was growing of local authorities to go outside their own areas. Circumstances had forced it upon the attention of Parliament, and no definite policy had yet been thought out. There were cases where neighbouring corporations, wishing to connect their respective tramways, had found it necessary to form a connecting link through the district of some suburban authority. In such a case Parliament had not refused the necessary power. The Board of Trade was much concerned to know what Parliament thought ought to be done as regarded the applications from municipalities to go outside their own areas, whether for electric lighting, gas, or tramways. The applications were becoming so numerous, and the circumstances so varied, that they looked for Parliamentary guidance as to the provisions which should govern municipal outside action—whether there should be joint action, Government, and administration, or whether it should be left to one municipal authority to administer within its own area. He wished to pay a tribute to the excellent municipal management of affairs. There were many instances of good, economical, and wise management, and he should regret if anything he had said seemed to show a mistrust of municipalities. His point was that if they traded outside their own districts, Parliament should consider upon what principle, under what limitations, and upon what organisation they should go.

Sir L. LYELL: When a municipality buys out an electrical undertaking which is partly within and partly without its own area, what becomes of the statutory right of a local authority to purchase the undertaking outside the municipal area?—It is not destroyed.

The Committee then adjourned.

CORRESPONDENCE.

Electric Light Wires and Dust.

This phenomenon was observed by me about two years ago. It seemed so singular that a switch or a ceiling rose should gather more dust than any other ornament on the wall or ceiling that we gave the matter careful consideration, which resolved itself into falling back on the electrostatic phenomena. This very soon disclosed to us that we could have the electrification continuously kept at the ceiling rose or switch just as we cared. The phenomenon is the same as when you electrify an ebonite rod and make it pick up particles of dust or paper. The electrification is not very great on the ceiling rose or switch because the P.D. is not very high, but sufficient to attract minute particles of dust that may be flying about and make the accessories very unsightly. As it is easier to clean the switch than the ceiling rose where electrification is the cause of the dust, we arrange for all our switches to govern the positive wires, thus leaving as much as possible of the circuit at the same P.D. as the earth. We made an attempt to earth the switch cover, but, due to surface leakage, the idea was abandoned, and a dark teak-wood block substituted at the back of the switch, which detracts from the eye the dust mark; we also arrange the positive side for the Corporation.

More attention ought to be given to + and − wires where worked at high P.D.'s, and by switching the positive wires you reduce to a minimum all risks and strains on your installation.

J.

Edinburgh, *May 21st*, 1900.

Electrical Engineering in H.M. Navy.

Being a constant reader of your valuable paper, usually so accurate, it startled me to find you had published a letter by Mr. S. Mason in your issue of March 9th with several mistakes. The first and most glaring is the statement that no electrical staff is provided in the Royal Navy. I need only remind you of our *Vernon* and *Defiance* to set Mr. Mason right in this matter. The Fleet Engineer does not rank with the Captain, neither does he wear four gold stripes. The representative of the E.E. in a ship of war is the torpedo officer for the time being, not the E.R.A. It may interest Mr. Mason to know that the E.R.A. whom he quotes, received his electrical education from the executive. I quite agree with your correspondent there are many problems to be solved afloat; but I will venture to assert we have a staff quite capable of coping with the task without

placing greater responsibility on the engineers, which responsibility now terminates at the machine terminals. From this point everything is taken charge of by the Torpedo Staff, which consists of torpedo lieutenant, torpedo warrant officer, torpedo instructor, leading torpedo men, and seamen gunner torpedo men and armourers. These men are capable of the care and maintenance of incandescent and searchlight circuits, electromotors, accumulators, and all other electrical work incidental to the naval service, including submarine mining, telegraphy and telephony, without the assistance of the engineers. That our heads of department are not behind the times is evidenced by wireless telegraphy being successfully experimented with before Mr. Marconi published his superior results. It is well known that the Admiralty specification for ship dynamos exercised a most wholesome effect on dynamo design, even though a "promoted shipwright" *was* responsible for it. Our rank and file are not far adrift either, as I notice that on leaving us, they fill with credit fairly responsible positions in the profession on shore. Now that sails have gone and a modern man-of-war contains a good deal of electrical machinery, the executive *have* learnt, and take as great pride in handling these machines, as their forbears did the sails. The allusion to the American system is rather unfortunate, as it is openly admitted by American officers a failure. It would be fun to know how many captains there are who do not know "time taken to raise steam" from cold water or otherwise.

Ernest C. Hooper.

Aurora, China,
April 16th, 1900.

[We do not hold ourselves responsible for the statements of our correspondents. Mr. Hooper evidently refers to the letter by Mr. S. F. Walker.—EDS. ELEC. REV.]

Distributing Systems for Electric Traction.

It would be ungracious of me to complain of Mr. Thomas Tomlinson's article dealing with my paper on the above subject, in your issue of May 11th, yet I think he misreads my paper in some particulars; perhaps, the fault is in my mode of expression.

He thinks that I started out by studying a particular system, and then drew from the results certain general deductions as an after-thought. This is not the case. The paper commences by pointing out the general conditions to be fulfilled by the distributing system, and then discusses the general laws of economical distribution so conditioned, and shows how they affect the choice of system of generating the power.

The calculations for the particular system illustrated are given simply as a concrete application of the general principles; no general deductions are drawn from the results of these calculations, and no general superiority is claimed for one or other of the systems discussed. The attempt was to show how the best generating and distributing system could be selected by the application of general principles to any case.

Mr. Tomlinson makes a point raised by some others, that the calculations are based on hypothetical data. (I prefer the word "estimated" or "prophetic.") On what else can they be based? The whole of a tramway system is based on estimated traffic or service necessarily. A bridge engineer similarly uses an estimate of maximum rolling load which is usually just as "hypothetical" as the predicted tramway service. Just as his bridge should be the most economical under the conditions of span, &c., to carry the estimated rolling load with a given factor of safety, so will tramway feeders, calculated as I have shown they may be, supply a given service with maximum total economy.

Whether this end should be aimed at, or equipment at the lowest capital cost at first, is a question of financial policy rather than engineering. The calculations will at any rate help the engineer who advises the financiers to give them a clear knowledge of the alternatives, and in the case of public bodies there seems no reason for the course suggested by Mr. Tomlinson.

I am glad, at any rate, that Mr. Tomlinson recognises so frankly the advantages of working out the feeders in the way I advocate, a method for which I claim no originality of course, but which I have not seen put forward before in a practical way.

The "obvious truism" as to selection of sites quoted, is very far from obvious to the average director or committeeman, and therefore, I think it is still worth saying, whenever its iteration may, perhaps, produce result. I agree that it ought to be unnecessary by this time.

Henry M. Sayers.

May 22nd, 1900.

Reply to "N. C. W.'s" query on page 828.—The Midland Electric Wire Company could supply the tinned iron and other wires.—GENT & CO., Leicester.

COMPULSORY PURCHASE OF ELECTRICAL UNDERTAKINGS.

In these days when municipalities vie with each other in developing and working tramway systems, gasworks, and electric lighting installations, the private company must sometimes recall with trepidation the words of the Act of Parliament which give power to the local authority to purchase their undertaking. Much has been said and written as to the propriety of municipal trading; it has entailed in some places an increased burden to the hapless ratepayer, while in some districts the profits earned during the year have materially diminished the unwelcome calls which are made from time to time on the pocket of the householder; and a careful study of the subject may possibly reveal the fact that municipal trading is carried on at a profit in towns where the local authority is necessarily made up of men of business habits, whereas there is often a balance on the wrong side of the street in non-manufacturing towns. To discuss the question whether municipal trading is right is not our present purpose. Nevertheless, an inquiry as to the means whereby the local authority may wrest their entire stock-in-trade from a prosperous electric lighting or power company is well worthy of attention. Are the terms upon which this somewhat arbitrary power may be exercised, such as must commend themselves not only to the taxpayer but to the shareholder and all other persons whose money is invested in, and whose income partly depends upon the prosperity of an electric light undertaking? It is with this question that we now propose to deal.

First and foremost, it should be stated that the matter does not appear to be of any very pressing moment, except, possibly, in a few cases where the companies have embarked upon their industrial career hampered and restricted by "provisional orders" of a very unusual character. As we shall presently see, the length of the period which must elapse before the local authority can exercise its option to purchase at a valuation will, in most cases, carry us on to about 1921. Until the expiration of that period, or of the shorter period specified in the provisional order, those connected with electric lighting companies may still breathe freely.

The first statutory provision relating to this subject is to be found in Section 27 of the Electric Lighting Act, 1882 (45 and 46 V., c. 56). It was there provided that the local authority might, after the expiration of a period of 21 years, or after every subsequent period of seven years, purchase the undertaking compulsorily, or so much of the same as was within their jurisdiction, upon certain terms, to be determined in case of difference by arbitration:—"Provided that the value of such lands, buildings, works, materials and plant, shall be deemed to be their fair market value at the time of the purchase, due regard being had (1) to the nature and then condition of such buildings, works, materials and plant; (2) to the state of repair thereof, and the suitability of the same to the purposes of the undertaking; and (3) where part only of the undertaking is purchased, to any loss occasioned by severance, but without any addition in respect of compulsory purchase or of goodwill, or of any profits which may, or might have been, or be made from the undertaking, or of any similar considerations." As it was found that the periods above mentioned were too short, the foregoing section was repealed by the Electric Lighting Act of 1888, 51 and 52 V., c. 12, Section 2 of which is practically a re-enactment, with these important differences, namely, the period of 42 years, *or such shorter period as is specified in the provisional order or special Act*, is substituted for the period of 21 years; the period of 10 years, *or such shorter period as is specified in the provisional order or special Act*, is substituted for the period of 7 years; and for the purpose of arriving at the market value, the words "and to the circumstance that they are in such a position as to be ready for immediate working," are added to the matters to which due regard is to be had. No addition, however, is to be made for goodwill or compensation for compulsory purchase, the law remaining, so far as this matter is concerned, in the same state as before.

If the passages printed above in italics stood by themselves—that is to say, if the question of arranging the period within which compulsory purchase is to become allowable rested entirely with the undertakers and the Board of Trade, the provisional order might be framed so as to allow the full statutory periods to run before the undertakers could become exposed to the risk of being "bought up." In London it has been customary to provide that the period of 42 years shall always commence to run from August 26th, 1889. We find, however, that by Section 1 of the Act of 1888, notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority, shall be granted by the Board of Trade *except with the consent of the local authority*, unless the Board of

Trade are of opinion that such consent should be dispensed with. Seeing that the local authority have a qualified *veto* upon every provisional order, it is submitted that they might make use of their veto by objecting to the length of the period at the expiration of which they may themselves acquire the undertaking. Whether any local authority have ever exercised their power in this manner we are unable to say; it is clear, however, that the power exits if they only choose to use it.

What, then, are the terms upon which the supply company may be compelled, at the expiration of the specified period, to part with their stock-in-trade? An arbitrator may (according to Section 2 of the Act of 1888) determine the price, but without any addition in respect of compulsory purchase or of goodwill, the lands, buildings, &c., are to vest in the local authority, freed from any debts and mortgages. It is commonly supposed that the decision of the arbitrator is final upon this point, but it is important to notice that by Section 3 of the Act of 1888, notwithstanding anything contained in Section 2, the Board of Trade may, by any provisional order to be made by them under the Electric Lighting Act, 1882, vary the terms upon which any local authority may require the undertakers to sell. Such variation could, it is submitted, be made *after* the commencement of the original order, and it is conceivable that the Board of Trade might have power to order payment of compensation for goodwill or compulsory purchase. As we have seen, the time is not ripe for the occurrence of any case in point; electrical undertakings are of comparatively recent date, and but a small portion of the statutory period of 42 years has elapsed. Nevertheless, it may be some consolation to those who fear the exercise of this power of compulsory purchase to know that something equivalent to a right of appeal lies to the Board of Trade from the decision of an arbitrator, who in the proper performance of his duty refuses to award any compensation for goodwill or compulsory purchase.

It is not easy at first to understand why the customary 10 per cent., so readily paid to those whose lands are taken for the purposes of a railway, or other undertaking of a nature beneficial to the public, is denied to those whose enterprise has resulted in the establishment of a wealthy and prosperous electric lighting company. A little reflection, however, will show that there is a reason—a reason which is founded upon the maxim *salus populi suprema lex*. In acquiring certain rights and privileges by virtue of a provisional order or a special Act, the company is, in a modified degree, placed in the position of a monopolist, although, as is well known, a rival company may obtain similar privileges in the same district. A limit is placed upon the prices which may be demanded for electricity; borrowing powers are conferred; licenses to uproot public streets, to acquire lands compulsorily, and in many other ways to interfere with the general public, is freely granted. In return for favours thus extended to them, the company must be prepared to risk the chance of being bought up by the local authority at a price which will not involve the ratepayers in payment for goodwill or compensation for compulsory purchase. The public have already been put to a certain amount of inconvenience; is it fair that they should be asked to pay for that which was originally granted, under restrictions, to the supply company? That the interest of the public is of prime importance, may be gathered from the fact that the local authorities, as undertakers, are not allowed to make a profit of more than 5 per cent.

Even assuming, therefore, that when the time comes for the local authority to claim its right to purchase electric lighting undertakings at a valuation, no allowance is made for goodwill or compulsory purchase, the unbiassed critic can scarcely say that the Legislature which confers the power of supplying electricity is "derogating from its own grant," for the promoters of a company must be taken to have had full knowledge of their rights and liabilities when the company was floated. Nevertheless it is pleasing to find that by conferring a certain power of revision upon the Board of Trade, those who framed the Act of 1888 have provided a loophole through which undertakers may escape the consequences of what sometimes appears to be harsh legislation.

As we stated in an earlier part of this article, there is no immediate cause for anxiety, and it is possible that the experiences of the next decade may prove that municipal enterprise is unsatisfactory and undesirable from every point of view. Under such circumstances, the local authority would scarcely venture to exercise the powers vested in them by Act of Parliament.

BUSINESS NOTES.

Adjustable Curves.—We have received an improved form of Clark's patent adjustable curve for drawing smooth curves of any ordinary shape. The instrument consists of a strip of celluloid, about 10 inches long, to the ends of which are rivetted two strips of brass; by means of a cord passing through these, and an adjustable rod for modifying any part of the curve, it is easy to rapidly adjust the curve so as to pass through, say, a series of points on squared paper, such as the volt-ampere curve of a dynamo. A similar instrument, for ship and railway curves, &c., consists of a strip of tough elastic wood about 30 inches long, fitted up in the same way as the smaller one, but of course on a more substantial scale, with polished nickel attachments. We have made trial of both instruments and found no difficulty in accurately reproducing curves drawn at random. Although they are somewhat expensive, their cost is far less than that of the complete sets of French curves which would be required in their place, and there can be no doubt as to their utility.

Electrical Wares Exported.

Week ending May 23rd, 1899.		Week Ending May 2nd 1900.	
Alexandria. Teleg. mat.	Value £412	Adelaide. Teleph. mat. ..	Value £98
Amsterdam	165	Alexandria	73
Antwerp. Teleg. mat.	152	Amsterdam	250
Bombay	123	Boca. Teleg. mat.	76
Borneo	54	Bombay	223
„ Teleg. mat.	205	Boulogne	86
Boston	35	Buenos Ayres	727
Boulogne	13	„ Teleg. mat. ..	200
Brisbane. Submarine cable ..	1,219	„ Teleph. mat. ..	74
Buenos Ayres	2,186	Calcutta	700
„ Teleg. mat. ..	174	„ Teleg. wire	355
Calcutta	948	Cape Town	171
Cape Town	28	Chinde. Teleg. mat.	864
Colombo	299	Colombo	135
Durban	401	Copenhagen. Teleg. wire ..	38
East London	87	Durban	211
Flushing	18	East London	9
Gothenburg	66	Flushing	9
Hamburg. Teleg mat.	150	Hamburg.	300
Hong Kong	15	„ Teleg. mat.	700
Madras	271	Melbourne	197
Melbourne	205	Riga. Teleg. mat.	64
Odessa	25	Rio Janeiro	1,497
Ostend	10	Rotterdam	45
Port Chalmers	1,440	Rouen	50
Port Elizabeth	216	Santos. Teleg. mat.	199
Rotterdam	37	Singapore	42
Shanghai	101	„ Teleg. mat.	65
Singapore	71	Sydney	1,300
„ Teleg. mat.	68	„ Teleg. mat.	89
St. Petersburg	71	Vigo. Teleg. apparatus ..	179
Stockholm	200	Zanzibar. Teleph. apparatus	71
Sydney	740		
„ Teleg. mat.	140		
Tientsin	650		
„ Teleg. mat. ..	200		
Trinidad. Teleg. mat.	85		
Vigo	800		
Vladivostock	130		
„ Teleg. mat. ..	42		
Yokohama	356		
Total ..	£12,708	Total ..	£8,993

Foreign Goods Transhipped.

Durban	Value £33	Trinidad. Elec. lgtg. apps.	Value £44
Philadelphia	28		
Trinidad. Teleg. mat.	93		
Total ..	£154		

Auction Sales.—From an advertisement in another part of this issue it will be observed that Mr. J. C. Platt will offer for sale by auction at the Mart, on Monday next, some valuable freehold premises and land in Hammersmith, suitable for electricians, hydraulic engineers, &c.

In another notice particulars are given of an auction sale to be conducted by Messrs. Percy Huddleston & Co., at Manchester, on Friday, June 1st, of the stock and plant of an electrical engineer. The catalogue details a new 8 H.P. gas engine, a compound-wound dynamo (110 volts, 50 amperes), one ditto. 100 v. 50 amps., one shunt dynamo 65 v. 18 amps., one 50 v. 6 amps., a number of electric motors, arc lamps, switchboard, a quantity of vulcanised cable and wire, and a large variety of electric fittings and accessories, &c.

The Belleville Boiler.—The report as to the repudiation by the Admiralty of the Belleville boiler has been flatly contradicted, and so also has all that the *Engineer* has said about the tube difficulty. *Engineering* now takes on itself the task of upholding the Belleville boiler, and goes so far in its advocacy as actually to state that the Admiralty had a long series of experiments carried out before the type was adopted. We attach no value to the statement that this boiler has been most largely adopted by the navies of the world. The *Engineer* very pointedly asks how it is, if the tubes of the Belleville boilers have not failed, there has been £10,000 spent on the *Terrible* boilers? *Engineering* makes light of this experience, and says it was due to an unfortunate accident not necessarily inherent to the system. *Engineering* leaves itself a loophole for escape by expecting that another boiler may get a chance, but states fairly bluntly that the Belleville boiler will not be replaced, and that it has given satisfactory results. The *Engineer's* statement that no tubes had been made of British steel for a long time was contradicted. The *Engineer* points out that though this may be so, the steel was after all made of Swedish pig, and this practically means the same thing. Then again, if the lap-welded tubes have really proved satisfactory, as it is now made out, why all this fuss about solid drawn? No matter how the matter is looked at, there is strong suspicion that all is not well. Our own strong objection to a flattened spiral 90 feet long, may perhaps make us unduly pessimistic. We do not think it has done so. The *Engineer* rightly condemns 30-hour tests as inadequate and calls for trials of days. *Engineering* takes up the cudgels for the Admiralty, and lauds the system of submitting Admiralty designs to a consultative committee of chief inspectors of machinery at Portsmouth and Chatham and chief engineers at Portsmouth. All the consultative committees in the world will not render a 20-bend 90-foot tube a safe structure to stand above a fierce fire, and we cannot believe that any engineer or body of engineers, unbiassed by the outside influence of friends against their own inclination, freely and voluntarily set it down as their belief that such a boiler could give satisfaction. As *Engineering* takes up so uncompromising an attitude, and ignores everything known against the Belleville boiler and makes light of all the faults, it is fair to assume that our contemporary represents officialism. We trust that the question once awakened, will not, however, be allowed to subside into quiescence. The safety of the country demands something more than the soothing of the *amour propre* of the system

that has led the Navy into such a muddle. If the Belleville boiler is so super-excellent it is strange that the French Navy is not by any means enamoured of it and is trying other forms to-day. We hope the full truth will in time come to the top in spite of all efforts to smooth matters over.

Bankruptcy Proceedings.—Notice is given of a second and final dividend of 9d. in the case of S. G. Trehearne and A. H. Crump (Trehearne, Son & Crump, electrical engineers and contractors, 155, Fenchurch Street).

Liquidations, Dissolutions, &c.—The Universal Electrical Advertising Syndicate is winding up voluntarily, with Mr. T. G. Mellors, of King John's Chambers, Nottingham, as liquidator.

A meeting of the Calcium Carbide Company is to be held at 28, Old Christchurch Road, Bournemouth, on June 19th, to hear an account of the winding up from Mr. F. Courtenay, liquidator.

Messrs. J. Webster and J. Ellis (Webster & Co., electrical engineers, Leeds), have dissolved partnership. Mr. Webster carries on the business and attends to debts.

A petition for winding up the River Plate Electric Light and Traction Company is to be heard before Mr. Justice Wright on Wednesday, May 30th. The petition was presented by Messrs. Glyn, Mills, Currie & Co., bankers.

Messrs. A. W. Isenthal and C. P. F. M. Potzler (Isenthal, Potzler and Co., electrical engineers, &c., 85, Mortimer Street, London), have dissolved partnership. Mr. Isenthal attends to debts and will continue the business.

"Blitz" and "Fix."—"Blitz" is the name of a composition for tinning and leading copper, brass, tombac, iron, &c., and also for plumbing; while "Fix" is a soldering stone box for tinsmiths, coppersmiths, plumbers, &c. These specialities are the subject of a circular which has come to hand from Messrs. Hecht and Co., of Finsbury Pavement, E.C.

Book Received.—"Chemistry, an exact Mechanical Philosophy," by F. G. Edwards. London: J. & A. Churchill. 1900. 3s. 6d.

Catalogues and Lists.—The British Westinghouse Electric and Manufacturing Company, in its circular No. 1,027, dated May, 1900, describes the Westinghouse system of incandescent street lighting. While the arc system is preferable for business streets, the incandescent system is said to give a more uniform distribution of light for residence streets, particularly curved or heavily shaded thoroughfares of smaller towns. The Westinghouse system, which has been under practical test for twelve years, is called a "street light shunt coil," and it is entirely automatic, has no moving parts whatever, and is very simple in its general construction. It consists of a single coil of wire wound within a complete magnetic circuit of laminated iron. It may, therefore, be considered a modified form of a transformer. The coil is completely enclosed in an iron box. One of these coils is connected in shunt with each incandescent lamp. The coils are so designed that when 100-volt lamps are used, ten of them may be placed in series on a 1,000-volt circuit, or a proportionate number for any other voltage. In an installation where the pressure is 1,000 volts, twenty 50-volt, or ten 100-volt coils, are connected in series on a single loop of wire, each coil serving its own lamp. The lighting district is covered by the requisite number of these loops, each of which is a single wire similar to an arc light circuit. These loops are preferably served from a separate line controlled at the station. If more convenient, they may be taken off from any point of the mains supplying the general commercial service. A full and illustrated description of the system is given in the pamphlet before us.

Messrs. Peirson & Co., of St. Dunstan's Hill, E.C., send us a copy of their January list of high-class constructional steel and iron work. This firm was responsible for the whole of the ironwork at the Bankside Electricity Works, its contracts with the City company amounting to above £25,000. Other electrical contracts executed by them include constructional work at the Dover, Dublin, and Leyton electricity works, the Bristol and Dublin electric tramway works, and the Telegraph Construction and Maintenance Company. Roofing and flooring plates, columns, tanks, ornamental ironwork, and so forth, find a place in this small list of 48 pp.

Messrs. Dick, Kerr & Co. have sent us their circulars, Nos. 102 and 103, dated March and May respectively. 102 (12 pp.) contains illustrations of top-seat and single-deck motor cars, as supplied to Bolton, Potteries, Liverpool, and other places, also a view showing cars at the Preston Works. 103 illustrates the new rolling stock for the Waterloo and City Railway, and gives an efficiency curve of the "15 L" motor with which the new cars are fitted.

We have before us a catalogue from Mr. E. Ravet, of Clerkenwell Road, E.C., and Boulogne, in which are contained some details and prices of lathes, milling machines, screw and power presses, stamping machines, and machines for perforating celluloid. The catalogue is very fully illustrated and neatly arranged.

Messrs. Fletcher Bros., of Ashton-under-Lyne, send us an illustrated circular of their patent "Divergent" slide valves giving dimensions for draughtsman's use. The makers specially claim an advantage in the removable seating; when secured in position there is allowance for expansion diametrically. The cover being at the end an internal examination may be made, and any foreign substances be removed, without having to take down the valve body. The bye-pass is made with only one joint instead of four as hitherto. The valve is said to embody many simple and efficient improvements, which are the result of Messrs. Fletcher's experience in high pressures for steam pipe installations and with superheated steam.

Pamphlet No. 64 of the British Thomson-Houston Company describes and illustrates in the usual excellent manner the "1900" alternating current fan motors.

In connection with the Paris Exhibition, where they have a stand (No. 506 in Group V), the Electrical Power Storage Company have issued a small booklet regarding E.P.S. batteries, with illustrations of the various types, and also detailing some battery testing accessories.

The North British Rubber Company, of Edinburgh, have published a price list of belting, hose, tubing, and a variety of other india-rubber mechanical goods manufactured by them.

We have received from Messrs. D. H. Bonnella & Son, Limited, copies of three sections of their catalogue. (L) list deals with lighting accessories, switches, lamps, arc lamps, resistances, measuring instruments, and so on; (T) is devoted to telephones and accessories, including receivers, transmitters, complete wall and desk fittings, intercommunication sets, and numerous small parts; the third section is the electric bell list, wherein are included a host of pushes, pulls, batteries and bells of different types and prices, electro-medical apparatus. All of the lists are studded with illustrations of the various apparatus and articles coming under the above descriptions.

The International Electric Company, of Redcross Street, have sent us a copy of their new catalogue, where, in just over 200 pages, they have particularised a vast quantity of electric bell and telephone material. The increased attention which is, of necessity, being paid to the subject of telephony by municipal electrical engineers will naturally cause them to be on the look-out for priced catalogues such as this. We cannot afford space to indicate in any detail the various parts of telephone and bell systems illustrated in the book. We will be content with saying that the following convey a general idea of the ground covered:—Electric bells of all shapes and patterns, pushes and pushboards for wall and table use, indicators and indicator movements, relays, receivers, microphones, wall and desk telephones, "International" intercommunication sets, magneto stations, central and trunk line switchboards, line selectors, and a great variety of accessories, including wires, batteries, insulators, lineman's tools, and so on. There is a number of useful diagrams demonstrating how certain instruments should be connected for special purposes, and some notes are given indicating what information is necessary for preparing estimates for complete telephone exchanges.

Messrs. J. B. Corney, of St. John Street, W.C., send us a priced circular relating to their "Bryan Marsh" incandescent electric lamps. These lamps are said to have a useful life of 13,000 C.P.-hours on a 16 C.P. lamp, with a consumption of 3·5 watts per C.P.

The Copper Market in May.—Messrs. H. R. Merton and Co.'s statistical circular for the first half of May, shows that stocks have diminished by 431 tons in the 15 days, while the price of G.M.B.'s has fallen from £76 15s. to £73 2s. 6d., a drop of £3 12s. 6d. per ton. The heavy shipments to this country and to France in April, and consequent rise in stocks are no doubt the cause of this heavy fall in values, and it is reassuring to note that the shipments from North America during the first half of the current month are considerably above the average, and are actually in excess of the total shipments from North America in the whole month of May, 1899. The total supplies during the first half of May have been 11,723 tons; the total deliveries 11,904 tons, and in addition 250 tons Standard copper has been shipped to America from English ports. The stocks of copper, which on April 30th stood at 27,475 tons. have, therefore, fallen to 27,044 tons, but in spite of this slight reduction in stocks, the serious decline in values already noted has occurred. The shipments from North America, and from "other" countries have been above the average; while from Australia, Chili, and from Spain and Portugal, the shipments during the first half of May have been below the average for the preceding twelve months.

Electricity v. Punkah Coolies.—*Indian Engineering* says that the Government of India has issued orders for the installation of electric fans in barracks in all the more important military stations. In this same connection, it was suggested some time ago that the "power" might be derived from treadmills in the local jails.

Information Wanted.—A correspondent asks the name of the maker of Boyd's patent copper electrical hot plates for cooking, &c. Can any of our readers tell him?

Launches for Leeds.—The Roundhay Park Sub-committee of the Leeds Corporation has ordered an electric launch (to cost about £600) from Messrs. W. S. Sargeant and Co., of Chiswick, to be used as a pleasure boat on Waterloo Lake. The boat will be 53 feet long by 8 feet beam, will carry 45 passengers, and is to be delivered within ten weeks.

Outing.—The employés of the Leeds Corporation Electric Lighting Department, recently had an outing to Apperley Bridge, making merry with cricket, tea, and songs.

Railway Rates.—In response to the request of all the railways of the United Kingdom, the Board of Trade has resolved to amend the classification of merchandise, traffic, and schedules of maximum rates and charges, by adding to class (5) electroliers, phonographs, and photoscopes. Notice to this effect appeared in the *London Gazette* for May 18th.

Smoke Nuisance.—At the West London Police Court last week summonses were heard against the Electric Traction Company, Limited, at the instance of the Hammersmith Vestry, for allowing black smoke to issue from two shafts in Wood Lane, the Central London Railway generating station, in such quantities as to be a nuisance. It appeared from the evidence that cheap coal was being used for experiments instead of Welsh. On this account the magistrate decided only to grant a prohibitive order, and order the company to pay five guineas costs.

Trade Announcements.—Messrs. Clayton & Co., of Union Works, Huddersfield, inform us that they have purchased the whole of the business of the Penistone Electrical Company, Huddersfield and Penistone. Owing to the increased demand for their manufacture, Messrs. Clayton have extended the premises in Huddersfield, known as Union Works, and also put down the latest type of machinery to deal with the increasing requirements, both in cabinet work, switchboard, and electrical sundries generally. Mr. Richardson is the firm's London representative.

We understand that Mr. T. M. Harvey, who, until recently, was engaged in Messrs. Johnson & Phillips's Electric Cable Works, has left their employ.

Mr. Thomas Browett, joint managing director of Browett, Lindley and Co. (1899), Limited, has now entered into possession of the firm's London offices, which are situate at 6, Old Queen Street, Westminster, S.W.

Mr. Frank F. Wellington announces that he has purchased the business of The Motor Development Corporation, Limited (Tube Department), of which he has hitherto acted as manager. The business will be carried on at 36, St. George's Square, Regent's Park Road, N.W., under the style of Frank F. Wellington, and in conjunction with this he will also trade in new and second-hand motors, motor cars, &c. We have received a circular of his patent ignition tubes for gas and oil engines, motor cars, &c.

Westinghouse Work.—The New York *Electrical Review* says that "word has been received from Paris that the Westinghouse Electric Company has closed contracts for the equipment of the Metropolitan Underground Railway, of Paris, and the suburban lines of the Chemin de Fer de l'Ouest, of France. The company will also equip a large power house for supplying all the surface railroads of Paris with electric current, and has equipped the movable sidewalk at the Exposition, as well as an electric railway which runs through the Exposition grounds."

ELECTRIC LIGHT AND POWER NOTES.

Accrington.—A Local Government Board inquiry was held last week respecting an application of the Corporation to borrow £26,250 for electricity purposes; £18,000 has already been borrowed, so that the estimated cost will be over £44,000.

Chesterfield.—Mr. F. H. Tulloch, M.I.C.E., conducted an inquiry on behalf of the Local Government Board last week relative to an application by the Corporation for leave to borrow £25,000 for electric lighting purposes. It was stated that the probable demand was very heavy, amounting already to 12,242 8 C.P. equivalent. Apparently the Westinghouse Company has the scheme in hand. There was no opposition.

Dalkeith.—A scheme submitted by Mr. Purves on behalf of Messrs. Crompton & Co., Limited, for the electric lighting of Dalkeith and Eskbank, is under consideration by the Town Council.

Dublin.—At a meeting of the Corporation last week the Lord Mayor announced that the Local Government Board had granted the loan for electric lighting without any conditions attached, and had expressed approval of the scheme.

Gosforth.—The District Council has agreed to take supply from the Newcastle Electric Supply Company, Limited.

Ilkeston.—On 18th inst. a Local Government Board inquiry was held into the Corporation's application for sanction to borrow £18,271 for the purposes of electric lighting. The town clerk remarked that it was expected that there would be applications for 6,000 8 C.P. lamps. It was estimated that it would cost 2d. a unit to produce, while it was proposed to charge consumers 4d. The number of lamps applied for up to the present was 3,100.

Kingston-on-Thames.—Mr. J. E. Edgcome, the borough electrical engineer, in his report for the 15 months ending March 31st last, says that the new 200-KW. combined steam alternator now being put down will add further plant sufficient for 10,000 8-C.P. lamps installed on the circuit. The gross profit is £2,737 9s. 4d., and after paying interest there remains a profit of £1,298 11s. 4d. towards the repayment of capital, which, amounting to £1,346 10s. 3d., leaves an adverse balance of £47 18s. 11d., as against an adverse balance of £1,112 0s. 9d. in 1898. There is a rapid increase in number of consumers and lamps connected, the number of consumers having increased from 211 to 311, and the number of lamps from 11,856 to 16,130. In regard to public lighting, it will probably be found expedient and desirable to continue the public arc lamps throughout the main roads.

The Town Council has authorised application to the Local Government Board for sanction to the borrowing of £15,000 for further extensions of the electric light works. The works earned a profit last year of £2,739 odd, nearly sufficient to pay the interest and the repayment of capital.

Leeds.—The Corporation last week decided to apply for power to borrow a sum of £28,000, which, it is estimated, will be the amount required for the provision of new engines, alternators and boilers, to replace the old machines.

Leith.—Mr. Bryson, whose resignation of his post of electrical engineer we reported last week, has reconsidered his decision and desires to withdraw his resignation.

Lewes.—The Town Council has completed the transfer of its electric lighting order to the County of Sussex Electrical Power Distribution Company, Limited.

Lincoln.—Last week Mr. F. H. Tullock conducted an inquiry on behalf of the Local Government Board into the Corporation's application for power to borrow £6,000 for the extension of electric lighting in the city. A loan was sanctioned in 1897 for £20,650, and in 1899 there was another loan of £19,000 for extensions. Of the last-mentioned loan £4,500 was still unexpended, and the loan now asked for was to provide cables in the southern part of the city. The capacity of the present plant was 18,000 8-C.P. lamps, and with the proposed extension the capacity would be 25,000 8 C.P. lamps. There was no opposition.

London.—LONDON COUNTY COUNCIL.—At last week's meeting the Highways Committee recalled the fact that in March the Southwark Vestry had complained of repeated failures of the supply of electrical energy by the London Electric Supply Corporation. As a result of careful inquiry, the Committee came to the conclusion that there had been serious default on the part of the company, and on their recommendation the Council resolved to take proceedings to recover penalties in respect of the default. Six summonses were accordingly taken out against the company, being two each in respect of failures of supply to the Public Library, Borough Road, the Council's weights and measures offices in Union Road, and No. 148, Borough High Street. The Committee reported the course events had taken, dwelling at length upon the dismissal of the summonses by the magistrate at the Southwark Police Court on April 2 th, and the infliction of the full penalty by the Greenwich magistrate. Having regard to the great importance of the matter, and to the divergent views held by the magistrates at Southwark and Greenwich respectively, as to the company's obligation to maintain an efficient and constant supply under its orders, the Committee expressed the opinion that the decision of the magistrate adverse to the Council should be appealed against. On the recommendation of the Committee it was resolved to appeal against the decision.

BERMONDSEY.—The Vestry on Monday received a report from the Electric Lighting Committee covering letters from the consulting engineers, Messrs. Kincaid, Waller & Manville. The engineers reminded the Vestry that in their original report, presented in June, 1897, they proposed to lay down distributing mains for the supply of 4,000 8-C.P. lamps simultaneously alight. They now suggested that provision should be made for the supply of double that number of lamps. It was estimated that the total cost of the mains and feeders, with conduits, &c., would amount to about £6,000. The Committee instructed the Vestry clerk to obtain a further report from Messrs. Kincaid, Waller & Manville on the laying of larger mains, so that a supply could be given to the whole of the new Borough of Bermondsey. In reply, the engineers stated that the additions would amount to £3,310—extra distribution mains, £1,200; 28 arc lamps, £1,360; provision of extra ducts for added areas, £450; 10 per cent. for engineering, clerk of works, and contingencies, £300; making a total of £3,310. The Vestry approved the reports, and authorised the engineers to prepare specifications and to invite tenders for carrying out the work.

DEPTFORD.—At a meeting of the New Cross and Deptford Electric Light Users' Association last week, it was stated that the London Electric Supply Corporation had stated in reply to a letter from the hon. secretary that they were willing to give a rebate of 15 per cent. off all the accounts due at Christmas, but declined to allow anything off the accounts due at Lady Day. The meeting resolved that in view of the fact that the inconvenience and loss sustained were even greater in the quarter ended Lady Day than in the previous quarter, the accounts be not paid unless a rebatement of 15 per cent. be allowed on the Lady Day quarter as well as on the Christmas quarter.

HAMMERSMITH.—In a recent report to the Electric Lighting Committee, Mr. Bell, the electrical engineer, says that in the last year's working the number of consumers has increased from 275, with 19,390 8-C.P. lamps on March 25th, 1899, to 464, taking a supply for 26,365 8-C.P. lamps. The average number of lamps per consumer has decreased from 70 to 56. This is mostly due to the number of small flats in the parish which are wired for electric lighting. The department has received £3,375 for lighting and maintaining the 150 arc lamps in the public streets. Sixty-three additional arc lamps have been added since the last report. For private lighting the Vestry has sold 620,078 units, producing a revenue of £10,274 5s. 7d. (average under 4d. per unit). The annual revenue per lamp has gone down from 10s. 10d. to 9s., the price paid by consumers is the lowest but one in the London district. The total cost for generation, distribution, &c., is £7,764 14s. 11d., or 2·05d. per unit, a decrease of nearly ½d. per unit on last year, being 56·5 per cent. of the revenue, which leaves a gross profit of £5,974 0s. 10d., or 43·5 per cent., towards paying interest and sinking fund charges. The result of the year's working shows a net profit of £1,615. Although the cost of production has decreased, it is feared that these results may not be improved upon in the present year, owing to the greatly increased prices of fuel and other materials. The machinery now installed and in working condition will be able to supply a further 10,000 8 C.P. lamps, after allowing an ample margin for reserve.

HOLBORN.—The Board of Guardians of the Holborn Union has resolved to instal electric lighting plant in the City Road Workhouse, according to the designs of Mr. J. Enright, at an estimated cost of £7,623.

ST. MARTIN-IN-THE-FIELDS.—The public arc lamps were turned on last Wednesday evening all over the parish. Direct current 500-watt arcs are used, mounted on red standards ornamented with the equestrian figure of St. Martin sharing his cloak with a beggar.

Maesteg.—The District Council has decided not to apply for a provisional order.

Melbourne.—The *Melbourne Age* says that at a meeting of the City Council in April matters connected with the proposed extension of the city's electric supply undertaking were discussed. In the first place, the councillors had to decide as to the acceptance of certain tenders for the plant necessary to complete the council's works under the new *régime*. Into this consideration a patriotic issue had been imported, owing to the fact that the lowest tender for the engines, dynamos, &c., was that of a German firm. This firm's estimate was lower than that of an English company by between £3,000 and £5,000. It was felt by a powerful section in the council that, despite the extra cost, the English tender should be accepted. Another party, however, denied that patriotism had anything to do with the matter, and declared that the lowest tender should, as a matter of course, be accepted. This problem was, however, by no means the most important, for when the councillors met they found that the entire scheme was blocked by the Postmaster-General. To their astonishment, they learnt that Mr. Watt had suddenly decided that he had no legal power to transfer to the Corporation the rights of the existing electric companies. The meeting was conducted in private, but in the course of the debate councillors asked why this question of transfer had not been settled long ere this. The reply given was that the ex-Postmaster-General had been approached some time back, and had stated that there would be no difficulty about the transfer. Some councillors then took the line that the council should go ahead, despite Mr. Watt. Ultimately the council adjourned, without arriving at any decision concerning the tenders. It was resolved that the Mayor and the local representative of the Electric Light and Traction Company of Australia should see Mr. Watt, with a view to arranging a *modus vivendi re* the order for the transfer of rights.

Newcastle.—Before the Property Owners' and Ratepayers' Society of Great Britain last week, Mr. A. L. Armour, B.Sc., read, on behalf of Ald. Armour, of Gateshead, a paper on "The Electrical Distribution of Energy and Industrial Prosperity."

Partick.—The Electricity Committee of the Glasgow Corporation has agreed to supply electricity to the Burgh of Partick, under certain conditions, until the Partick electricity works is completed.

Portsmouth.—Last week Mr. E. A. Sandford Fawcett, A.M.I.C.E., held an inquiry into an application of the Corporation for sanction to borrow £9,975 for electric lighting extensions. It was stated that the demand for electric lighting was steadily increasing, and 14,000 8-c.p. lamps had been installed during the past year. There was no opposition.

Rhyl.—No less than 55 tenders have been received for carrying out the municipal electricity works. They have been referred to the engineers.

Salford.—Having received a letter from Mr. C. L. Turner to the effect that he was unable to comply with the Council's request that he should resign his position as Corporation electrical engineer, the Council on Friday last passed a resolution terminating his appointment, with three months' salary in lieu of notice.

Simla.—An Indian journal says that the Simla Municipality has applied for the services of Mr. Meares, Government electrical expert, to report on the feasibility of electrical lighting for Simla.

Sudbury.—A Local Government Board inquiry was held last week into the application by the Town Council for leave to borrow £13,000 for electric lighting purposes.

Sunderland.—An inquiry was held last week by Colonel C. H. Luard, R.E., Local Government Board inspector, into the application by the Town Council for leave to borrow £4,500 for electric lighting purposes.

Trowbridge.—The District Council has under consideration the advisability of applying for a provisional order for electricity supply.

Woking.—The Board of Trade has granted the provisional order asked for by the District Council.

ELECTRIC TRACTION NOTES.

Bath.—Last week the Urban Sanitary Authority affixed its seal to an agreement with the promoters of the light railways scheme, whose terms were stated in our last issue.

Birmingham.—The Lord Mayor of Birmingham and the Public Works Committee visited Liverpool last week in order to examine the working of the system of electric tramways which has been adopted by the Corporation.

Cardiff.—The Town Council last week had a discussion as to whether there should be a separate station for the electric tramway undertaking, or whether the Tramways Committee should take energy from the lighting station. In the end the voting was 20 in favour of, and 8 against, a separate station. An electric traction engineer is to be appointed at £500 per annum.

Dover.—The returns of the Corporation electric tramways at Dover for the last financial year show a profit of £3,155, a considerable increase on the preceding 12 months.

Glasgow.—A serious fire occurred at the grain stores of the Caledonian Railway Company at Glasgow on 15th inst. A pole carrying a large number of telephone wires was fixed on the building, and when the roof gave way the wires fell across the electric trolley wires of the tramways. The current from the trolley wires fused the telephone wires almost instantaneously. It is stated that several persons received slight shocks.

Horwich.—The Bolton Corporation have now practically completed the arrangements for the electric car service to Horwich.

Italy.—The *Board of Trade Journal* says that H.M. Consul at Milan reports that the experiment in electric traction on railways made by the Mediterranean Railway Company on its line from Milan to Monza, with accumulators, revealed certain serious defects which necessitated some considerable changes, and a partial and temporary suspension of the service. It is, however, believed that the modifications now in course of application will be entirely efficacious, and that the system of accumulators will prove to be best adapted to short distance journeys. This company is now about to try an experiment on a much larger scale on its line from Milan to Gallarate, and thence to Varese, Luvens, and Arona, about 73 miles of rail. The hydraulic power for producing electricity will be obtained from the River Ticino, at Tornavento, where the necessary works are to be commenced immediately. The system to be adopted is that of the third rail, which is already working satisfactorily in the United States, but over much shorter distances. The electric current will be transmitted to the third rail at a tension of 600 volts. The electrical apparatus required for the trains has already been ordered, and is to be delivered in April next year. The carriages themselves will be built at the Mediterranean Railway Company's own works. Contemporaneously, the Adriatic Railway Company will apply the trolley system on its line from Lecco to Chiavenna and Sondrio, 66 miles of rail. The hydraulic power will be derived from the River Adda, near Morbegno, and the overhead wire will be supplied with a current at a tension of 3,000 volts. In this case the electrical machinery has been ordered from a Hungarian firm, and is to be delivered at about the same time as that for the Mediterranean company.

Kingston (Surrey).—After a protracted discussion last week, the Corporation resolved to make application to Parliament next session for tramway powers in the borough.

Kirkcaldy.—Last week the Town Council considered the question of the proposed introduction of tramways and electric lighting. The Tramways and Electric Lighting Committee's recommendation was agreed to as follows:—"That the Council should proceed at once to establish both tramways and electric light, and, further, that it be remitted by the Council back to the Committee with powers to proceed with the work, including power to engage an engineer and to incur all the necessary initial expenses, but with the understanding that before the contracts for the building of the power station, the construction of the tramways, and the introduction of the electric light are entered into, the Committee shall report to the Council."

Leeds.—The receipts from the Leeds Corporation tramways for the 12 months ending March 25th amounted to £129,137, the gross profit on the year's working being more than £30,000. Compared with the previous year there is an increase in the receipts of £14,588. The introduction of electric traction on the Headingley and Chapeltown routes has been marked by the same success as that attending the Roundhay and Kirkstall lines.

The members of the Tramways Committee of the Leeds Corporation have decided to visit officially the International Tramways and Light Railways Exhibition, to be held at the Agricultural Hall, London, N, from June 23rd to July 4th.

London County Council.—At last week's meeting the Parliamentary Committee reported that in consequence of the refusals of the Vestry of Lambeth and the Wandsworth District Board to consent to certain electric tramway proposals, they had directed to be withdrawn from the Council's Improvement Bill the powers proposed with regard to the widening of thoroughfares in Lambeth and Streatham affected by the proposals.

The report of the Highways Committee reminded the Council of the rejection by the Light Railway Commissioners of the applications for three orders to authorise the construction of light railways between Deptford, Shooter's Hill and Woolwich, between New Cross, Lewisham and Eltham, and between Clapham, Wandsworth and Kingston Road. In this connection the Committee stated they had considered the question as to what course should be taken in view of the action of the Commissioners. They had come to the conclusion that the decision of the Commissions should not be appealed against, especially as the Council's Improvement Bill did not now contain powers for the Council to carry out the necessary street widenings in connection with the projected light railways. On the recommendation of the Committee it was decided not to appeal to the Board of Trade against the decision of the Commissioners.

The Council, at the weekly meeting on Tuesday, resolved to serve notices requiring the South London Tramways Company to sell to the Council certain lines in accordance with the purchase clause of the Tramways Act, 1870. The Finance Committee expressed the opinion that the lines would require reconstruction either for horse or electric traction.

The report of the Highways Committee stated that the Council were carrying out widenings of certain thoroughfares in which are single lines of tramway which would shortly become purchasable

under the Tramways Act, namely, in Battersea, Bermondsey, Wandsworth and Lambeth. In the opinion of the Committee it was desirable for the Council to obtain power to reconstruct the lines as double tracks, and for the work to be executed after the particular roads concerned had been widened. It was estimated that the expenditure for reconstructing the lines for an underground system of electric traction would amount to £43,000, whilst a further sum of £14,000 would be required for establishing the underground method on a new double track to be formed in the new street to be laid out between Bermondsey New Road and Tooley Street. The Committee therefore recommended:—

That the Parliamentary Committee be instructed to include, in one of the Bills to be promoted by the Council next session, powers for the Council (1) to double the single line of tramways in those portions of (*a*) Battersea Park Road, (*b*) Bermondsey New Road, (*c*) York Road (Battersea and Wandsworth), (*d*) Albert Embankment, and (*e*) Wandsworth Road, in which the Council is effecting widenings under powers already conferred by Parliament; and (2) to construct a double line of tramways along the new street from Bermondsey New Road to Tooley Street, authorised by the Tower Bridge (Southern Approach) Act, 1895.

At the suggestion of the chairman of the Council the consideration of the recommendation was postponed.

The Highways Committee reported that in view of the probability of the Council's Tramways (Electric Power) Bill (which is to authorise the Council to reconstruct for electric traction any tramways within the County of London which have been or shall be acquired by the Council) becoming law this session, they had in preparation the specification and form of contract for the supply of the rails, fish-plates, &c, which would be required in connection with the reconstruction of two sections. These were the tramways between Westminster Bridge and Tooting and those between Blackfriars Bridge Road and the Kennington terminus of the cable tramways. In this connection the Committee stated:—

It has been represented to us that the causes relative to wages and hours of labour, which the Council's Standing Order No. 212 requires shall be inserted whenever practicable in all contracts, are inapplicable in this instance, owing to the very special nature of the work and to the peculiar conditions obtaining in the trade as regards the payments made to the workmen engaged in the manufacture of rails. With reference to this matter we have had the benefit of the advice of Dr. Kennedy, and also of Sir David Dale, who has acted on many occasions as arbitrator between employers and workmen; and as the result we have had submitted to us, and have approved, a special form of clause which will, in their opinion, attain in another way the object aimed at by the hours and wages clauses usually inserted in contracts. This special clause we propose shall be inserted in this contract and also in any other contracts for the supply of tramway rails, &c., which may be required hereafter in connection with the reconstruction by the Council of its existing, and the construction of new, tramways. The General Purposes Committee, whose opinion was asked upon the matter, has informed us that it thinks that the proposed special clause might be adopted; and in the circumstances, we recommend—

That, as regards contracts for the supply of the rails, fish-plates, &c., required in connection with the reconstruction by the Council of existing, and the construction of new, tramways, the operation of the Council's standing order No. 212 be suspended so far as to permit of the omission of the usual clauses relative to hours and wages, and the insertion of a special clause as follows:—"All wages to workmen for work executed under this contract must be paid at the rates arranged between the employers and workmen in the rail trade in that part of the country where the order is placed. The Council reserves power to cancel this contract, so far as relates to any part of the articles specified therein not totally or partially manufactured, at any time on one week's notice, should it be proved to the satisfaction of the Council, after hearing both parties, that lower rates than the standard rates of the district have been, or are being, paid in the execution of this contract."

The recommendation was agreed to without discussion.

London.—In the House of Commons on Tuesday the London United Tramways Bill, as amended, was further considered, and an amending clause was inserted at the instance of Mr. Lough, providing for and regulating the maintenance of a cheap morning and evening tram service for artisans, mechanics, and daily labourers.

Middlesex.—The Light Railways Commissioners last Monday sat at Westminster to inquire into an application by the Middlesex County Council for permission to construct lines of electric tramways from Harlesden, through Sudbury, Wembley, and Harrow on the one side, and from Southgate to Finchley on the other. The total length of the lines is about seven miles, and the cost of construction and equipment is put at £117,000. The acquisition of land for necessary widenings is not included. According to the *Times* report, Mr. C. A. Cripps, Q.C., who appeared for the promoters, said that lines 1 and 2 were five miles long and ran through two districts which assented and one that did not. The Harrow School trustees objected, but as the line neither passed the school nor touched its property, he failed to see how they could be heard. After argument and evidence on this point, Lord Jersey said that the Commissioners saw no special reason why Harrow School should be heard. Evidence having been given in support of the scheme, the opposition was then heard. In Wembley there was an objection to the erection of a generating station, the opposition being summed up as being on the grounds of "smoke and sentiment." The Council withdrew two schemes for lines from Harrow to Watford, and Mr. Cripps incidentally mentioned that the differences between the County Council and the North Metropolitan Tramways Company, who were the joint promoters of the scheme which the Commissioners had passed, would, he thought, soon be settled. The negotiations were progressing satisfactorily. The inquiry was adjourned, the chairman stating that the Harlesden to Stonebridge section was passed.

Mossley.—Last week a special meeting of the General Purposes Committee of the Town Council considered the report of the joint committee appointed to inquire respecting the proposal for a scheme of electrical tramways and lighting for Mossley, Stalybridge, Hyde, and Dukinfield. In the report the scheme was strongly recommended, and it was suggested that each of the four Corporations should supply equal amounts for the capital outlay, receive equal profits or provide equally for losses, and be equally represented upon the joint committee of management. The estimated cost is £287,100. The report was approved.

Plymouth.—Ample testimony was borne at meetings of the Town Council last week to the success which has attended the application of electric traction to the Prince Rock section of the municipal tramways. Mr. J. C. Brown, the chairman of the Finance Committee, congratulated the Council on the fact that for the first time a deficit was absent from the accounts of the tramways. Last year they carried 3,783,867 passengers; in other words, they had carried the whole population of Plymouth 35 times over. If that were a shareholders' meeting he should, he said, propose the payment of a dividend of 6 per cent. As it was the profit of £4,800 had to be otherwise disposed of, and £2,495 was paid away for interest, and £1,595 applied towards buying up the property. He believed that when electric traction was applied to the northern section of the line, the trams would be one of the best paying properties owned by the Corporation. Mr. S. J. Page, the chairman of the Tramways Committee, mentioned that on the Prince Rock section the receipts from passengers showed an increase of 39 per cent., and in the winter half of the year, when the electric cars were in operation, exceeded those of the summer. In previous years the receipts had always fallen off in winter.

South Shields.—The Corporation announces in the *London Gazette* its intention to grant a lease of tramways to the South Shields Tramway and Carriage Company.

Surbiton.—The Light Railways Commissioners' inquiry into Messrs. Greenwood & Batley's tramway scheme is stated to have been postponed indefinitely. The Commissioners were to have sat at Kingston on 22nd inst., and the Surbiton Council was intending to oppose.

Switzerland.—A proposal is under consideration to construct an electric mountain railway from the Little Scheidegg up the Männlicher. The line would run from the existing station on the Little Scheidegg of the Wengern-Alp line *via* the left side of the Lauberhorn, and the Tschuggens to the Hotel Rigi Grindelwald (Männlicher), 2,345 metres above the level of the sea. The line which would be $4\frac{1}{10}$ kilometres long, is estimated to cost £16,000.

Underground Railways.—In the House of Lords last week the Charing Cross, Euston, and Hampstead Railway Bill was read a third time and passed.

In the House of Lords on Tuesday the Central London Railway Bill was read a second time.

In the House of Lords on 21st inst. the Whitechapel and Bow Railway Bill was read a third time. In the Commons the Baker Street and Waterloo Railway Bill was read a third time.

TELEGRAPH AND TELEPHONE NOTES.

The Eastern Telegraph Company.—In the House of Commons on Tuesday, in reply to Sir C. Dilke, the Chancellor of the Exchequer said:—Arrangements have been made with the Eastern Telegraph Company by which landing rights will be given for the cable to St. Vincent, one of the conditions of which is the laying of a cable from Ascension to Sierra Leone. The Eastern Telegraph Company has entered into an agreement with the colonies of West and South Australia and Tasmania to construct with all convenient speed the line from Durban to Mauritius, Rodrigues, Cocos, and Fremantle in West Australia, and thence to Glenelgin, South Australia, as soon as landing rights have been granted. Landing rights have been granted in Natal and in West and South Australia, and the company has been informed that Her Majesty's Government are prepared to approve the granting of landing rights at Mauritius, Rodrigues, and Cocos, and will issue licences as soon as the general form of licence now under consideration has been settled.

Imperial Telegraphic Communication.—The *Times* gives the following summary of the debate which took place in the House of Commons on Tuesday night on the above subject:—Sir E. Sassoon called attention to the subject of the cable telegraphs of the Empire, and moved that it was desirable to hold an inquiry with regard to the commercial and strategic defects of the present system. Referring to the recent failures that had occurred in the transmission of messages from the Cape just when it was most desirable that there should be no interruption of communication, he affirmed that the Associated Cable Companies had laid themselves open to a charge of dereliction of duty at the most critical hour of the country's need, and he asked whether any remonstrance had been addressed to the companies by the Government. Discussing the commercial aspect of the question, he showed that the earnings of the African companies had exceeded the amount which the late Sir J. Pender declared would constitute a remunerative revenue, and he insisted that they ought to have reduced their tariffs accordingly. Criticising the arrangements between the Indian Government and the Indo-European company, he asked that the rate for messages should be reduced to 1s. per word. He also contrasted the high charges for messages from this country to Egypt with the very low charges for messages between France and Algiers and Tunis. He expressed an earnest hope that the scheme for the all-British Pacific cable to Australia would be proceeded with; and he contended that provision ought to be made in all future agreements with the companies for a scale of charges based upon average earnings; that no concessions should be granted to any system that diverged from or conflicted with the all-British route; that no absorption of any new line by old companies should be permitted without the express sanction of the State; that the State should be able to assume ownership when such a step was

dictated by public interests; that when a cable broke down for the best part of three months owing to avoidable causes some suitable penalty should be inflicted; and that no exclusive privileges in restriction of competition, except when dictated by some imperious temporary necessity, should be granted.

Sir C. Dilke, in seconding the motion, dwelt on the great usefulness of submarine cables in time of war and on the desirability of having alternative cables.

Mr. Vicary Gibbs defended the associated cable companies against the strictures which had been levelled against them, and

Mr. Buxton supported the demand for an inquiry, holding that the country ought to hear what the real policy of the Government was with regard to the question of submarine telegraphy.

Mr. Griffith Boscawen having also passed some criticisms upon the existing state of things,

Mr. Hanbury replied, remarking at the outset that the British companies had built up a system under which we obtained the first news from any part of the world. So efficient, in fact, was the service that it was exciting the jealousy of foreign nations. He reminded the House that the Government had reserved the right of purchasing the strategic cables, and said that they were not prepared to buy up the commercial cables, even if it would be fair to the companies to do so. For some of the alleged defects of the service competition was the remedy. The companies did not pretend that the Government had granted them anything in the nature of a monopoly. The Indo-European Company, however, he admitted, had attempted to create an artificial monopoly to the disadvantage of the public, and it was also true that this company had not reduced its rates for a good many years. Now, however, as a result of the negotiations between the Indian Government and the company, it was practically arranged that there was to be a reduction of the rate to 2s. 6d., and in certain eventualities a further substantial reduction at a future time. Speaking of other companies, he said that in the last nine years they had made large reductions in their charges. Turning to the strategic side of the question, he named the places which were already connected together by all-British cables, and the places to which such cables were to be carried. The general conclusion to which he came was that neither from the commercial nor from the strategic point of view was there much ground for dissatisfaction with the existing position of affairs. But the Government kept the whole subject constantly in view, and were quite ready to hold any inquiry which they deemed expedient. An inquiry, if undertaken, would be departmental in character, for this was not a matter which it was politic to investigate in public.

Sir E. Sassoon regretted that the right hon. gentleman should have refused to appoint a Select Committee, and proposed to divide the House, but after Mr. Balfour had assured him that an inquiry such as he asked for would be very undesirable, strategical questions being involved, he consented to withdraw his motion.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	... June 30, 1899 ...	...
Trinidad-Demerara (1891)	... Oct. 23, 1899 ...	May 16, 1900.
Trinidad-Demerara (1871)	{ Working badly. May 11, 1900.	
Mole St. Nicholas-Cape Haitien	... March 6, 1900 ...	...
Cayenne-Pinheiro	... Oct. 11, 1899 ...	...
Cayenne-Paramaribo ...	... Feb. 16, 1900 ...	...
Ceará Maranham	... Feb. 20, 1900 ...	...
Pará-Maranham	... March 1, 1900 ...	...
Latakia-Cyprus	... June 20, 1899 ...	...
Manila-Iloilo	... Apl. 9, 1900 ...	...
St. Thomé-Loanda	... May 20, 1900 ...	...
Tarifa-Tangier	... Jan. 2, 1900 ...	...

New cable, Pará-Pernambuco, opened for traffic on May 18, 1900.

Landlines.		
West Indies:—		
Communication with Port de Paix (Haiti)	May 16, 1900 ...	May 17, 1900
Communication with interior of Haiti	May 20, 1900 ...	May 21, 1900
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899 ...	...
Communication beyond Newcastle	Nov. 7, 1899 ...	...
Communication with all offices beyond Kimberley and Kroonstad	Oct. 18, 1899 ...	...
Communication with all offices of Colombia beyond Buenaventura...	Feb. 22, 1900 ...	...
Communication "*viâ* Hanekine" interrupted on Persian Territory	Feb. 24, 1900 ...	...
Ecuador landlines	Mch. 13, 1897 ...	...
Brazilian landlines, south of Macahe	Apl. 25, 1900 ...	...
Moulmein-Bangkok	May 7, 1900 ...	May 19, 1900

The Telephone Service.—As the result of his investigations during a 13 months' tour through Europe and America, Mr. T. Howard, an officer attached to the Victorian Postal and Telegraph Department, who was specially commissioned by the Government to inquire into the telephone system of Europe and America, has submitted to the Postmaster-General a comprehensive report, from which we make the following extracts:—

In the United States, Canada and Italy, the telephone business is entirely in the hands of private companies, while in Great Britain and Ireland, Denmark, Norway and the Netherlands, the local systems are managed by private corporations, but the trunk lines in each country are in the control of the State. Outside of Stockholm, where the State is in competition with the private company, the service in the rest of Sweden is in the hands of the Government. In the other countries the Government have full control of the service.

The telephone business of America has for many years been in the hands of private organisations, the head quarters of which are at Boston, from which point directions are issued, and a general healthful supervision exercised. The parent company, as it is called, has licensed, and it controls, 46 telephone companies, each of which has an area allotted to it, and these companies provide local exchange services for the whole of the United States. Each private company is self managed, and has its own directors, but it is nevertheless subservient to the supervision and control of the management at Boston. The advantage of the monopoly is the establishment of a uniformity of work and service that is greatly beneficial. The form of apparatus used, the method of working, and the manner of construction, are all dictated from Boston, with the result that the service as a whole is thoroughly and splendidly performed.

In Great Britain and Ireland the telephone business has suffered many vicissitudes, but it is now a practical monopoly in the ownership of the National Telephone Company. The opposition offered by the Post Office has not hitherto been very successful. If the Post Office operated in any area, the National Company stepped in, and by giving telephones for nothing, frequently induced Post Office renters to come on to their system. Revenue lost in one direction was more than made up in another, but as soon as the Post Office disappeared from the field, the rentals were at once raised to their former scale, and very often increased. From one cause and another, therefore, the telephone service of the British Post Office has not flourished, neither has the telephone *pure et simple*.

In 1896 the trunk system was purchased by the London Post Office, and by the Telegraphs Act of 1890, power is given to properly enter the field as a competitor, a sum of £2,000,000 having been voted by Parliament for this purpose. As the commercial centre of the world, London has certainly been behindhand in the past in the acceptance of the valuable science of telephony, but a very different state of affairs should exist within the next five years. An order to telephone London is a much more difficult problem than the order to telephone any other city, but both the British Post Office and the National Telephone Company now thoroughly understand the business, the systems are rapidly being reorganised on the latest and most up-to-date lines, following closely upon the best American practice, and London should shortly assume a position in the telephone world more in unison with its vast importance as a business centre. The license of the National Company expires by effluxion of time in 1911, but whether it will be bought up before then or not is a matter for the future.

The latest form of switchboard is the central battery one, and it is strongly recommended that all the principal Melbourne exchanges should at once be equipped with this form of switch. New York, Boston, Chicago and Philadelphia, are fitted with this type, and its use will soon be universal in America and the British Post Office, and the National Telephone Company have adopted it as their standard form, so equipped, and its use is extending very rapidly in Stockholm, Brussels, Antwerp, and other places. In this form of switchboard there are no batteries at subscribers' telephones; nor is there any handle or generator for the subscriber to ring up the exchange. All he has to do is to take his receiver off the hook, which action lights a small glow lamp at the exchange, and attracts the immediate attention of the operator. When the conversation is finished, the subscriber has simply to hang his receiver on the hook, in order to give the disconnection signal. He has no ringing off to do, nor is there any provision for him to ring either on or off. All signalling is done automatically, and the irritating interruption on the part of the exchange operator—"Did you get them?"—"Have you finished?"—is entirely dispensed with, because the supervisory lamps at the exchange tell the operator whether the wanted subscriber has answered or not, and all the subsequent movements of a conversation. After once answering a call by saying "Number, please," the operator's voice is never heard.

In the United Kingdom the construction of the telephone trunk system is undoubtedly the finest in the world. The trunk lines erected by the British Post Office vary in gauge from wires weighing 100 lbs. per mile to wires weighing 800 lbs. per mile. The system has been designed with a view to provide for conversations through submarine cables and through city underground work between London, Glasgow, Belfast, Dublin and the Continent of Europe on the one side, and between the chief provincial centres on the other. The longest line in the kingdom is that between London and Cork (800 miles), going through a submarine telephone cable in the Irish Channel; but London has also four telephone lines to Paris, which cross the English Channel. I tried the London to Cork and London to Paris lines, and found the speaking excellent. In America I spoke over lines from New York to Chicago (969 miles), from Chicago to Louisville (300 miles), and from New York to Boston, and found the speaking very clear and distinct. When on the Continent I spoke over lines from Zurich to Berne, in Switzerland (220 kilometres) and from Vienna to Berlin (660 kilometres), but the Swiss talk was much more satisfactory in its clearness than the Austria-German one.

Speaking generally, the average number of calls per subscriber is the same for both the United Kingdom and the United States, viz, eight per day. The actual figures at different exchanges in the States vary very much, according to whether the subscriber pays on a "flat" rate or a toll basis. In some cases, the subscribers with unlimited use of the telephone average 40 calls per day in the States, and 18 to 24 in England, whereas with a measured service this may

drop to three. Records showing this relationship are not yet kept on the Continent, but the intention there is to inaugurate such records.

Every administration visited is very decided on the point that non-subscribers have no privileges in the use of the telephone. They might just as reasonably claim the use of the telegraph for nothing. The effect of a measured service rate is to settle the much vexed question of non-subscribers, as every time the telephone is used it has to be paid for.

Telephone Wires.—Robert Williams, manager to C. J. Grist & Co., contractors, of Gracechurch Street, was summoned before Mr. de Rutzen last week under the Overhead Wires Act, 1891, for failing to comply with the London County Council by-laws as to the distance allowed between supports to such wires. Mr. Francis Robinson, who appeared for the Strand Board of Works, said that the defendant's firm were contractors who undertook the fixing of private telephone wires. In this case, says the *Times* report, they had fixed a wire between York Street and Tavistock Street with a span of 165 yards, the limit under the by-laws being 115 yards. Inspector Gregory, of the Board of Works, said that the span had since been reduced by 20 yards, and an attempt had been made to reduce it to 90 yards, but the insulator was not properly fixed, and rendered the wire more dangerous than before. A fine of 40s. and costs was imposed. On a second summons for failing to report the fixing of this wire, the defendant was ordered to pay the costs. A third summons charged the defendant with failing to affix a distinctive mark to the supports that the local authority might be able to distinguish them from those of other companies. Inspector Gregory said that, though notice was given to the defendant's firm over a year ago, they had not even taken the trouble to submit a mark for the approval of the London County Council. A fine of 40s. and costs was imposed, Mr. de Rutzen saying that it was most important that firms such as the defendant's should acquaint themselves with these by-laws and comply with their provisions.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bootle.—June 16th. The Corporation wants tenders for underground electric cables, the erection of arc lamps, and the supply of mechanical stokers, for electric lighting. See "Official Notices" to-day.

Bradford.—May 31st. The Corporation wants tenders for a coal-conveying apparatus and hoppers, also ash-conveying apparatus at the electricity works. See "Official Notices" May 18th.

Bradford.—June 7th. The Corporation wants tenders for a switchboard for 500 volts pressure, or for alterations to the existing switchboard at the Valley Road electricity works. See "Official Notices" to-day.

Bridgwater.—June 7th. The Council wants tenders for the supply of boiler house plant, engine house plant, dynamos, pumps, switchboard, mains, lamp-posts, accumulators, meters, crane, &c., for electricity supply. See "Official Notices" May 11th.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Crewe.—May 26th. The Council wants tenders for the supply and laying of about 25,000 yards of three-core cable, and 500 lampholders and reflectors for adapting the existing lamp-posts for electric lighting. See "Official Notices" May 11th.

Crewe.—June 11th. Tenders are wanted by the Corporation for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting (separate quotations for arc and incandescent lighting) the same. Tenders to Town Clerk.

Devonport.—May 25th. The Corporation wants tenders for electric light and traction feeders, distributors, boxes, &c. See "Official Notices" May 11th.

Dundee.—May 31st. The Council wants tenders for the overhead equipment of four tramway routes. See "Official Notices" May 18th. Another notice invites tenders for coal and electricity meters.

Durban.—June 29th. The Corporation wants tenders for overhead equipment for (*a*) about 16 miles of single track, including poles, overhead trolley wire, distribution boxes; (*b*) 22 double-deck motor cars; (*c*) steam and electric generating plant, including three 250-KW. generators, boilers, condensers, cooling towers, switchboard, &c. See "Official Notices" May 18th.

Ealing.—June 11th. The District Council wants tenders for storage batteries and a steam dynamo alternator for the electricity works. See "Official Notices" to-day.

Egypt.—July 1st. Tenders are being invited until July 1st by the harbour and lighthouse authorities at Alexandria for the supply and erection of the necessary plant and apparatus required for the electric lighting of the harbour of Port Said. Tenders are to be sent to L'Administration des Ports et Phares, Alexandria, whence particulars may be obtained.

Glasgow.—June 12th. The Corporation wants tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each, for the electricity department. See "Official Notices" May 11th.

Great Yarmouth.—May 31st. The Electric Lighting Committee wants tenders for the supply of coals for the electric light station for a period of 6 or 12 months from June 1st next.

Grimsby.—June 1st. The Corporation wants tenders for arc lamp-posts and brackets. See "Official Notices" May 18th. Another notice invites tenders for a number of electric meters.

Italy. — July 14th. The Municipal authorities of Maddalena (Sardegna), are inviting projects and tenders until July 14th, for the electric lighting of the public streets of the town. Particulars may be obtained from, and schemes and tenders are to be sent to, Il Municipio di Maddalena (Sardegna.)

Kilmarnock.—May 28th. Tenders are wanted for one 60 KW. or one 80 KW. dynamo, continuous current 210 volts. Price, with weight, size of shaft, length of journals, and other details fully specified, to be delivered to Andrew Barclay, Sons & Co., Limited, Caledonia Works, Kilmarnock, by Monday morning.

Leeds.—May 28th. Tenders are wanted for two or three 630-KW. two-phase generators, and one or two sets of surface condensing plant, for the electricity works. See "Official Notices" May 4th.

London.—June 1st. The City Corporation Streets Committee invite proposals for the hire of an electrically-driven dust cart. See "Official Notices" April 20th.

London.—The Postmaster-General invites applications for specifications for galvanized iron strand stay wire for telegraph purposes. See "Official Notices" May 4th.

London.—June 4th. The Fulham Vestry wants tenders for the wiring of the electric lighting works. Conditions, specifications, &c., at the offices of Mr. F. H. Medhurst, on payment of a deposit of £3 3s., returnable as usual.

London County Council.—June 16th. The Council invites tenders for an electric lighting and power installation (excluding generating plant) telephones, fire alarms, &c., at the Horton Asylum, near Epsom. See "Official Notices" May 18th.

Manchester.—June 9th. The Tramways Committee wants tenders for the overhead equipment of three routes of tramways. See "Official Notices" to-day.

Newcastle-on-Tyne.—June 1st. The New Tramways Committee wants tenders for switchboards, underground feeders, and pumping apparatus. See "Official Notices" May 11th.

Partick.—June 8th. The Commissioners want tenders for a dust destructor with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. See "Official Notices" May 18th.

Russia.—The municipal authorities of Vladivostock are at present inviting proposals for the electric lighting of the town, and also for the construction and working of an electric tramway.

South London.—June 2nd. The South London Electric Supply Corporation wants tenders for the complete installation of 3,000 lights on the premises of 500 consumers in any part of the area of the company's supply, and for the installation of two arc lights on the premises of any consumer in the same area. See "Official Notices" May 18th.

Southampton. — May 28th. The Corporation wants tenders for a water-tube boiler, with steam and other pipes, and sundry ironwork for the electricity works. See "Official Notices" May 11th.

Spain.—July 7th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7th next, for the concession for an electric tramway from the Puerta de Hierro (Madrid) to Aravaco and Pozuelo. Some particulars may be examined on personal application at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

St. Pancras.—June 7th. The Vestry wants tenders for re-arranging and additions to bare copper strip conductors. See "Official Notices" to-day.

Sleaford.—June 12th. Tenders for multitubular boilers, two steam dynamos and booster, pumps, waterheater, pipework, accumulators, arc lamps, posts and connections, switchboard, cables, and grounding are wanted by the Urban District Council. See "Official Notices" to-day.

Stockholm.—May 28th. The Secretary of State has received a despatch from H.M. Consul at Stockholm, stating that tenders are invited by the Royal Administration of Swedish Telegraphs, for the supply of 10,000 metres of copper wire. Some particulars may be examined on personal application at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Sutton Coldfield.—June 21st. The Corporation invites tenders for water-tube boilers and other steam plant, pipework, three steam dynamos and boosters; batteries, switchboard, overhead traveller, mains and conduits, arc lamps and posts, and station lighting. See "Official Notices" May 18th.

Tanat Valley.—June 5th. The directors of the Cambrian Railways Company are prepared to receive tenders for the construction of a light railway, about 15 miles long, 4 feet 8½ inches gauge, commencing by a junction with the branch of the Cambrian railways at Port-y-waen, in the county of Salop, and terminating at Llangynog, in the county of Montgomery. Plans, specification, and quantities obtained, on payment of £1 1s., at the office of Mr. A. J. Collin, engineer to the Tanat Valley Light Railway Company, Oswald Road, Oswestry.

Walthamstow.—May 29th. The District Council wants tenders for arc lamps, posts, accessories, and glow lamps on existing gas standards. See "Official Notices" May 11th.

CLOSED.

Birkenhead.—The Klein Engineering Company, Limited, have received an order from the Corporation to erect at their Craven Street generating station one of their patent counter current jet condensers with cooling tower for engines of 1,200 H.P.

Cheltenham.—The Corporation has just placed an order with Messrs. Witting Bros., Limited, of London, E.C., for two of their standard over-compounded railway generators, to be direct coupled to Belliss engines. Each of these machines will be of 150 KW., and will supply current to a light railway in the neighbourhood.

London.—The Bermondsey Vestry on Monday accepted the tender of Messrs. Hughes & Stirling, amounting to £2,581, for the erection of the chimney shaft in connection with the electric light and refuse destructor works. The tender of the same firm was recently accepted for the supply of the refuse destructor and boilers for the same works.

Northumberland County Lunatic Asylum.—Subject to the approval of the Local Government Board, the Visiting Committee of the Northumberland Lunatic Asylum have accepted the tender of Messrs. McAulay, Clark & McLaren, of Glasgow, for the electric lighting of their asylum, to the specification of Mr. A. A. Campbell Swinton. 31 tenders were received.

Plymouth.—Six tenders were received by the Tramways Committee of the Plymouth Corporation for the supply and erection of the overhead electric equipment of the Compton section of the tramways. The Committee recommended the Council to accept the lowest—that of the British Insulated Wire Company, Limited, which was for material, £2,950 14s. 8d., and erection, £319 8s. 9d., a total of £3,270 3s. 5d. At the suggestion of Alderman Radford, the chairman of the Electricity Committee, the Council rejected the Committee's recommendation and accepted the next tender, that of Messrs. R. W. Blackwell & Co., Limited, which amounted to £2,827 6s. 5d. for material, and £606 11s. 5d. for erection, a total of £3,433 17s. 10d. Alderman Radford said the difference in amount was small. Messrs. Blackwell & Co. had already fitted up one section of the line, and did it so admirably that the Board of Trade inspector said it was the best he had seen. The other tenders were in the sums of £3,764, £4,120, £4,140 and £7,571. In the last case the cost of material was put at £3,560 and erection at £4,011.

FORTHCOMING EVENTS.

Friday, May 25th.—At 5 p.m. Physical Society meeting at the rooms of the Chemical Society. Agenda:—(1) Experiments illustrating the Aberration called Coma, by Prof. S. P. Thompson, F.R.S.; (2) "Notes on the Measurement of some Standard Resistances," by Mr. R. T. Glazebrook, F.R.S.; (3) "On the Strength of Ductile Materials under Combined Stresses," by Mr. J. J. Guest.

Monday, May 28th.—At 4.30 p.m. Society of Arts, Foreign and Colonial Section. "Imperial Telegraphic Communication," by Sir Edward Sassoon, Bart.

Friday, June 1st.—At 9 p.m. Royal Institution of Great Britain. Discourse by Sir Henry Roscoe, F.R.S. Subject: "Bunsen."

NOTES.

Obituary.—We regret to learn of the death from dysentery at Naauwpoort, on May 9th, of George Herbert Pickles, an electrical engineer, and son of Mr. T. H. Pickles, iron-founder, of Nutclough, Hebden Bridge. In March Mr. Pickles went out to South Africa to serve in the St. John's Ambulance Brigade. He was only 24 years of age, but has filled several electrical engineering appointments, among them being one with Mr. R. S. Blackburn, another with the National Telephone Company in Ireland as fault inspector, and more recently at the Leeds electricity works. Just previous to his departure he had joined his father's business at Hebden Bridge.

Institution of Electrical Engineers.—No further nominations having been received, the Council nominees are duly elected, and the following constitute the Council and honorary officers for 1900-1901. The names in italics are those of the Council's nominees now elected to fill vacancies, and the names marked with an asterisk (*) are those who have been re-elected :—

President.

Prof. J. Perry, F.R.S.

The Past Presidents.

Vice-Presidents.

W. E. Langdon.	R. K. Gray.
James Swinburne.	*Mons. E. Mascart.*

Members of Council.

Major P. Cardew, R.E.	A. J. Lawson.
H. H. Cunynghame, C.B.	P. V. Luke, C.I.E.
H. Edmunds	W. M. Mordey.
S. Z. de Ferranti.	R. P. Sellon.
John Gavey.	*C. P. Sparks.*
Robert Hammond.	A. A. Campbell Swinton.
Hugo Hirst.	A. P. Trotter.
J. E. Kingsbury.	

Associate Members of Council.

W. R. Cooper, M.A., B.Sc. | S. Evershed.

R. W. Wallace, Q.C.

Honorary Auditors.

*Frederick C. Danvers.** | *E. Garcke.**

Honorary Treasurer.

Prof. W. E. Ayrton, F.R.S., Past President.*

Honorary Solicitors.

*Messrs. Wilson, Bristows & Carpmael.**

The annual general meeting of the Institution was held yesterday at the Society of Arts to receive the annual report of the Council and the statement of accounts and balance-sheet for the 12 months ending December 31st, 1899. The receipts for the year were—Annual subscriptions £4,338, and entrance fees £743, making, with sundry items, £5,414 for the year. The expenditure was £4,300 odd, leaving £1,113 balance carried to the general fund. The building fund, which stood at £5,277 last year, is now £7,044. The general balance-sheet shows that £1,437 was transferred to this fund.

The committee of the Irish Section will not be altered in any respect this year as active work has only just been commenced. This announcement was made on April 26th, and as no additional nominations have been received, the committee is made up as follows :—

Prof. G. F. Fitzgerald, F.R.S., *Chairman.*	R. Humphries.
Col. C. F. C. Beresford, *Vice-Chairman.*	M. C. Olsson.
Prof. W. F. Barrett, F.R.S.	G. F. Pilditch.
C. A. Burge.	A. E. Porte.
C. P. C. Cummins.	M. Ruddle.
F. Gill.	P. S. Sheardown.

It is provided by Rule 7 that all members of the committee shall be elected annually by ballot. The chairman and vice-chairman shall not hold office for more than one year consecutively, and no member of the committee except the honorary secretary shall remain on the committee in the same capacity for more than three years consecutively.

Appointments Vacant.—The Cardiff Corporation wants a tramways electrical engineer at £500 per annum. See "Official Notices" to-day.

The Shrewsbury Lighting Committee wants an assistant electrical engineer at £90 per annum. See "Official Notices" to-day.

A cashier and book-keeper is required in connection with the Glasgow Corporation telephone exchange system. See "Official Notices."

Personal.—The Shoreditch Vestry has appointed Mr. R. Wilson, of Walthamstow, clerk of works for the new generating station about to be built in Haggerston. There were seven applications for the post.

Alexandria, whence particulars may be obtained.

ing. See "Official Notices" May 10th.

Electric Rolling Bridge and Crane at the Paris Exhibition.—The Paris Exhibition has been open for more than a month, but it must be admitted that the machinery and electrical rooms are very behindhand. It is impossible to give any description whatever of these departments. We may, however, mention specially the electric "rolling bridge" and crane constructed by the firm of Carl Flohr, of Berlin, as it has rendered great service in the installation of the machinery in the German Hall. The accompanying figure gives a general view of this rolling bridge. It consists of two vertical members separated by a distance of 27 metres. These uprights are formed of a trellis-work of beams, resting on a caisson formed of another trellis-work of beams. Then come two caissons with solid sides mounted on trucks moving along rails. The two vertical members, 12·50 metres in height, are connected by two straight beams with horizontal trellis-work. At the top, supported by uprights, is a parabolic arch formed of lattice-work. On the two horizontal beams of the bridge is a carriage which moves in the direction of its breadth. It is set in motion by an electromotor of 8 KW. running at 500 revolutions per minute. This carriage bears a windlass which can raise a load of 25 tons at the rate of 2·4 metres per minute. The windlass is worked by two electromotors of 18 KW., excited in series, and turning at the rate of 450 revolutions per minute. Lastly, the rolling bridge can be moved along the hall for a length of 107 metres. To effect this, an electromotor of 26 KW., placed in the middle of the upper horizontal beams, works a horizontal axle, which transmits the movement to vertical axles in the uprights, and thence the movement is transmitted to the wheels of the trucks. This electric rolling bridge receives current from a provisional central station worked by a gas engine. It has been working continuously for several months, and has been of great service.

ELECTRIC ROLLING BRIDGE.

Theory of Wireless Telegraphy.—An interesting discussion on this question between Prof. Franklin and Dr. Pupin will be found in the *Transactions of the American Institute of Electrical Engineers* for March. Prof. Franklin differs from Dr. Pupin, who thinks that a small logarithmic decrement is necessary for successful wireless telegraphy. Franklin considers that the logarithmic decrement is due more to radiation of electric energy than to resistance in the vertical conductor, and that therefore rapid damping is a sign of powerful radiation. The effects to be obtained from resonance he considers are insignificant, and this appears to agree with practical experience. Franklin agrees with most other authorities in considering that the electrical oscillations of a conducting staff, perpendicular to an infinite conducting plane, are precisely the same as the oscillations of an isolated staff of double length. Dr. Pupin would have it appear that the staff and plane is a distinct and much more complicated oscillating system.

Electric Dust Figures.—When electricity is discharged from an electric machine upon a plate of insulating material it spreads itself out in curious patterns, which can be made visible to the eye, by sifting on the plate a powder consisting of a mixture of sulphur and red lead. This powder invented by Villarsy in 1788 has long been used for the production of the so-called Lichtenberg figures. It is usually stated in the text-books that the powders rub against each other, the red lead becoming positive, and sulphur negative; the sulphur is, consequently, attracted to the parts where there is positive electrification on the disc, and settles down in branching yellow streaks, while the red lead settles down in little red heaps and patches where the electrification is negative. Bürker, who has been investigating this subject (*Ann. der Phys.*, 4th series, Vol. i., p. 474), finds that this statement, like many others in the text-books, must be taken *cum grano salis*. The red lead and sulphur do not become positively and negatively electrified, and there is very little difference in colour of the figures on positive and negative charges. After trying a great variety of powders, Bürker finally discovered a mixture of the three powders which gave much better results than anything hitherto attained. The constituents of this mixture were one part (by volume) of carmine, three parts of lycopodium, and five parts of flowers of sulphur. When the positive charge was dusted with this powder, it came out a beautiful dark red, and the negative bright yellow. The best method of showing the figures is to coat a brass plate with a thin layer of asphalt, connect this plate to one pole of a small induction coil, and spray the surface of asphalt by gently touching it with the other pole. In making up the mixture, it is best to first mix the carmine and sulphur, rubbing them well together, and then to add lycopodium. The mixture may be sifted from a linen bag on the plate, though any other convenient means may be employed.

The Electric Power Schemes.—The attitude of the Parliamentary Committee which is now considering these Bills certainly promises well. Although its decision in regard to any one scheme will not be given until the whole of them have been considered, Sir James Kitson, when the case of the Tyneside and Durham Bills had been concluded on Wednesday, said that they had arrived at the following opinion:—

That the value of electrical energy as a means for the transmission and application of power has been amply demonstrated, and its importance to the industries of this country is admitted. The Committee accordingly advise that it is of public advantage to facilitate measures which may ensure a general supply of electrical power to all consumers who may seek to avail themselves of the economy and efficiency offered in the service of these sources of application of power.

We imagine that this will take the heart out of some municipal opponents who have been occupying so much of the Committee's valuable time.

Coming to London to see how to do it.—Our New York namesake on the 9th inst. stated that:—

President W. H. Baldwin, jun., of the Long Island Railroad, sailed on the *Kaiser Wilhelm der Grosse*, last Tuesday, to make an inspection of the Central Underground Railroad, in London. He hopes to acquire valuable information on the working of the tunnel roads in the English metropolis to apply to the tunnels which the Pennsylvania and New York Central roads propose to build in conjunction with their newly acquired Long Island property.

Engineering Students as Marksmen.—A rifle shooting competition took place on Wednesday last week between teams of four members each from the Central Technical, University, and King's Colleges, the Royal School of Mines, and the Crystal Palace Engineering School. The conditions were 10 shots each at 500 and 600 yards. The highest score was made by the C.T.C., with 297 out of a possible 400, the other competitors following in the order named. The winning team received a cup presented by the professors of the various colleges, and Mr. C. E. Vines, of the C.T.C., was presented with a cup given by Prof. A. K. Huntingdon for the highest individual score.

NEW COMPANIES REGISTERED.

Automobile Trust, Limited (65,967.)—This company was registered on May 17th, with a capital of £100 in £1 shares, to carry on the business of manufacturers of, and dealers in, all kinds of vehicles, whether drawn or propelled by animal, steam, oil, electrical, or other power, cycle manufacturers, india-rubber manufacturers and merchants, &c. The first subscribers (each with one share) are:—A. W. Hosle, 116, Craven Park Road, N.W., accountant; A. T. Prudey, 40, Holborn Viaduct, E.C., registrar; T. T. Bradbury, 40, Holborn Viaduct, E.C., secretary; J. A. Likeman, 40, Holborn Viaduct, E.C., salesman; C. Osborn, Rensbury, Kinsfield, Watford, gentleman; R. H. Ward, L.R.C.P., L.R.C.S., 46, Fetter Lane, E.C., physician and surgeon; and H. G. Thomas, 36, Greenwood Road, Hackney, gentleman. Registered without articles of association.

M'Alpine's Electrical Company, Limited (4,540).—This company was registered in Edinburgh on May 14th, with a capital of £5,000 in £10 shares, to acquire and carry on the business of electrical engineers carried on by H. M'Alpine & Co. at 248, Hope Street, Glasgow. The first subscribers (each with one share) are:—H. M'Alpine, 248, Hope Street, Glasgow, electrical engineer; John Dewar, 248, Hope Street, Glasgow, electrical engineer; James Paterson, 248, Hope Street, Glasgow, clerk; Alex. M'Omish, 79, West Regent Street, Glasgow, chartered accountant; John Dewar, 35, North St. Mungo Street, Glasgow, printer; Alexander Macallan, 24, Canning Place, Glasgow, joiner; and James Findlay, 41, West George Street, Glasgow, writer. The number of directors is not to be less than three nor more than five; the first are Hugh M'Alpine, John Dewar, and two others to be afterwards appointed; qualification in the cases of H. M'Alpine and J. Dewar 80 shares, others 10 shares. Registered office, 248, Hope Street, Glasgow.

Ingleton Water Power Company, Limited (65,930).—This company was registered on May 14th, with a capital of £7,000 in £1 shares, to acquire the business carried on by the Ingleton Carbide Company at Ingleton Mill, Yorkshire, to adopt an agreement with P. Middleditch, J.P., and to carry on the business of calcium carbide manufacturers and merchants, and any other business which may be conveniently carried on in connection with water, steam, or electric power. The first subscribers (each with one share) are:—T. R. Eskrigge, 5, Cook Street, Liverpool, gentleman; P. B. Fogg, The Hollies, Bromborough, gentleman; P. Middleditch, Halstead, near Kirkby Lonsdale, manufacturer; J. Carter, 1, Granville Road, Blackburn, lime burner; W. Lupton, 109, Manchester Road, Burnley, cotton waste dealer; J. J. Carter, Waddington Road, Clitheroe, manager; and Annie Lupton, 109, Manchester Road, Burnley. Table "A" mainly applies.

British Motor Traction Company, Limited (65,923).—This company was registered on May 14th, with a capital of £100 in £1 shares, to carry on the business of tramway constructors and proprietors, steam, oil, electrical and other motor manufacturers, bicycle, cycle, and velocipede makers, &c. The first subscribers (each with one share) are:—A. W. Hoale, 116, Craven Park Road, Harlesden, N.W., accountant; A. R. Pendry, 40, Holborn Viaduct, E.C., clerk; C. Osborn, Rensbury, Kingsfield, Watford; T. T. Bradbury, 40, Holborn Viaduct, E.C., secretary; J. Likeman, 50, Effingham Road, Hornsey, N., clerk; W. F. Cornell, 44, Woodstock Road, N., wine merchant; and R. H. Ward, 46, Fetter Lane, E.C., physician and surgeon. Registered without articles of association.

Midland Electric Corporation (1900), Limited (65,932).—This company was registered on May 15th, with a capital of £200,000 in £1 shares, to promote the development of the undertaking and business of the Midland Electric Corporation for Power Distribution, Limited, to adopt an agreement with the British Insulated Wire Company, Limited, and to carry on the business of electricians, mechanical engineers, suppliers of electricity for light, heat, motive power and otherwise, &c. The first subscribers (each with one share) are:—W. M. M. Forwood, 15, Union Court, Liverpool, solicitor; A. E. Haptie, 5, Darham Road, Seaforth, Liverpool, manager; C. O. Grindrod, 11, Knowsley Road, Rock Ferry, Cheshire, solicitor; F. W. Lintern, 22, Beaumont Street, Liverpool, book-keeper; T. M. Waters, White House, Flaxakerley, near Liverpool, book-keeper; J. A. Bland, 4, Eastview, Wright Street, Egremont, Cheshire, accountant; and E. R. Williams, 115, Grantons Road, Liverpool, accountant. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first; qualification, £500; remuneration, £200 each per annum (£300 for the chairman), and 10 per cent. of the net profits remaining after 10 per cent. is paid, divisible.

International Electric Traction and Power Syndicate, Limited (65,949).—This company was registered on May 16th with a capital of £25,000 in £10 shares, to adopt agreements with J. M. Hewitt, A. J. Lawson, Messrs. Bennett and Ward Thomas, Messrs. Knowles and Russell, F. Smith, and J. Hood, and to carry on the business of rolling stock and vehicle manufacturers, electrical, mechanical, chemical and hydraulic engineers, suppliers of electricity, &c. The first subscribers (each with one share) are:—R. Le Neve Foster, Harrytown Hall, Bredbury, Cheshire, manufacturer; T. Pollock, Goodier House, Hyde, engineer; J. P. Bedson, Newton House, Hyde, M.I.C.E.; W. G. Rhodes, Stansfield Terrace, High Bank, Gorton, M.I.E.E.; C. J. Hall, 23, Fountain Street, Manchester, solicitor; R. D. Cohen, Guildhall Chambers, Lloyd Street, Manchester, merchant; and T. Harris, 8, Exchange Street, Manchester, chemical merchant. The subscribers are to appoint the first directors; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Guildford Electricity Supply Company, Limited (36,725).—This company's annual return was filed on April 21st, when 2,488 ordinary and 500 founders' shares were taken up out of a nominal capital of £20,000 in 3,900 ordinary shares of £5 each and 500 founders' shares of £1 each; £5 has been called up on the ordinary and £1 on the founders', resulting in the receipt of £12,940, in addition to which £2 has been paid on two forfeited shares.

Chelsea Electricity Company, Limited (20,486).—This company's annual return was filed on April 12th, when 34,000 ordinary, 6,000 preference, and 500 founders' shares were taken up out of a nominal capital of £400,500 in 74,000 ordinary and 6,000 preference shares of £5 each and 500 founders' shares of £1 each. £5 per share had been called up on 27,334 ordinary and 6,000 preference, resulting in the receipt of £166,670. 6,666 ordinary and 500 founders' shares are considered as fully paid.

SUPPLY STATION ACCOUNTS.

Nottingham Corporation Electricity Accounts.

The accounts of the Nottingham Corporation electricity supply undertaking are exceptionally favourable, and reflect great credit upon the engineer, Mr. Talbot. With a moderate capital expenditure, rapidly increasing output, and marked reduction both in price per unit and cost of production the figures indicate excellent management, and show no trace of that retrograde movement which was alluded to in our last issue as being unpleasantly evident in many accounts. We only hope that when the accounts of last year are dealt with the increase in price of coal and general rise in labour charges may not cause a backward tendency, although they must inevitably prevent the present rate of progress being maintained.

GENERAL STATEMENT.

	1897.	1898.	Increase.
Total capital expenditure ...	£75,996	£127,393	£51,397
Number of units sold ...	480,381	894,674	414,293
Maximum load in kilowatts...	737 kw.	1,099 kw.	362 kw.
Gross revenue	£10,737	£12,919	£2,182
Gross profit	£7,066	£7,774	£708
Average price per unit sold...	5·14d.	3·34d.	−1·80d.

The gradual and steady growth of the business is most clearly shown by setting out the units generated and sales for the two years preceding those under consideration, together with them, and it is to be hoped that the successful results attained will induce the Corporation to further extend the public lighting:—

	Units generated.	Maximum load. kw.	Private supply.	Public lighting.	No. of public arc lamps.
1895 ...	183,694	255	160,093	11,554	8
1896 ...	316,638	400	285,622	11,563	8
1897 ...	511,933	737	468,728	11,653	9
1898 ...	951,319	1,099	875,743	18,931	15

negative. Burker, who has been investigating this subject

their newly acquired Long Island property.

At the end of March, 1899 (the financial year, including 1898 accounts) the number of consumers was 850, and the lamp connections was an equivalent of 67,339 8 C.P., while the generating plant installed had a capacity of 1,622 KW. The scale of charges for supply from July 1st, 1898 was: for lighting "For any quantity not exceeding the equivalent of 100 hours of supply per quarter, or at the rate of 400 hours per year, at the maximum power demanded by the consumer, 4d. per unit; and for any further quantity, 2d. per unit." While for power, the price was then 2d. per unit for four hours' daily use, and 1d. per unit for all excess. At the end of the March quarter of 1899, this power scale was modified by eliminating the 2d. rate, and a uniform price of 1d. per unit was charged after that date. As a result of these reductions (as far as they applied to 1898 financial year) the receipts from sale of current fell from 5·14d. in 1897 to just over 3½d. in 1898, or by no less than over 1¾d., yet the net profit remained practically unaltered.

REVENUE STATEMENT.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current	£10,303	5·14d.	£12,429	3·44d.	−1·80d.
Meter rents	339	·17d.	303	·08d.	−·09d.
Attendance street lamps and consumers' connections	95	·05d.	187	·05d.	...
Sundry fees, &c.	...	...	...	...	...
Gross revenue ...	£10,737	5·36d.	£12,919	3·47d.	−1·89d.

The costs sheet is striking as showing a reduction in each item; the decrease being approximately ¼d. on the works' cost, and ¼d. on the total cost per unit.

COSTS OF PRODUCTION.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Coal	£1,071	·54d.	£1,610	·43d.	−·11d.
Oil, waste, water and engine room stores.	220	·11d.	376	·10d.	−·01d.
Salaries and wages incurred in generation and distribution.	730	·36d.	1,002	·27d.	−·09d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	407	·20d.	536	·15d.	−·05d.
Works' cost ...	£2,428	1·21d.	£3,524	·95d.	−·26d.
Rent, rates, and taxes ..	222	·11d.	277	·07d.	−·04d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	739	·37d.	970	·26d.	−·11d.
General establishment charges, stationery and printing, law charges and insurance.	282	·14d.	374	·10d.	−·04d.
Other expenses	...	...	...	...	...
Total costs ...	£3,671	1·83d.	£5,145	1·38d.	−·45d.

One of the satisfactory features of the profit statement is the method of dealing with the surplus in each of the years mentioned. Instead of dealing out doles which can hardly seriously affect the rates levied in a town of any importance, the whole of the surplus is transferred to the reserve fund to cover depreciation of the generating and distributing plant. This is an example other corporations might well follow.

PROFIT STATEMENT.

	1897.	1898.
Interest on loans	£2,168	£2,579
Sinking fund for repayments	1,397	1,621
Net profit carried to reserve fund	3,501	3,574
Gross profit	£7,066	£7,774

Portsmouth Corporation Electricity Accounts.

THE accounts of the Portsmouth Corporation electricity undertaking show a steady increase in output and load. The output in 1898 was nearly a quarter of a million units above that of 1897, and the total output has reached nearly 1¼ millions. The increase in maximum load is, however, proceeding at a greater rate than the increase in units, indicating that the districts from which consumers are now principally being drawn do not afford as good a load factor as the original area.

GENERAL STATEMENT.

	1897.	1898.	Increase.
Total capital expenditure ...	£112,174	£140,776	£28,602
Number of units sold	981,273	1,224,949	243,676
Maximum load in kilowatts ...	849	1,132	283
Gross revenue	£16,243	£20,523	£4,280
Gross profit	£6,881	£9,752	£2,871
Average price per unit sold ...	3·82d.	3·83d.	+·01d.

The revenue statement shows that the receipts per unit remain practically unaltered. Trivial increases in the second place of decimals are apparently indicated, but the sound policy, in face of the increased price of coal, has been maintained of retaining the price of 4½d. per unit, subject to small allowances. The sales were distributed as follows:—

	Generated.	Private supply.	Public lighting.	No. of public lamps.
1897 ...	1,216,560	591,314	389,959	257
1898 ...	1,521,062	802,499	422,450	261

The sundry receipts include meter testing fees, public fees, and small sums from the charging of accumulators and sale of ashes, and of old material.

REVENUE STATEMENT.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase
Sale of current ..	£15,624	3·82d.	£19,555	3·83d.	+·01d.
Meter rents	382	·09d.	588	·12d.	+·03d.
Supply of lamps, &c.	214	·05d.	302	·06d.	+·01d.
Sundry	23	·01d.	78	·01d.	...
Gross revenue	£16,243	3·97d.	£20,523	4·02d.	+·05d.

The costs are principally affected by the reduction in gross wages from £2,358 to £2,071, which gives nearly ½d. per unit drop. Taking this in conjunction with a fall in the gross amount for "oil, waste, &c.," and but slightly increased repair bill, the net result in the works' costs is to considerably more than balance the increased coal bill per unit, and the figure for works' cost shows an improvement of nearly ½d. per unit. The slight alterations in rent, &c., and management being in opposite directions, balance one another, and the total cost figures out as just over 2 1/10d. per unit, a creditable performance for a station situated as Portsmouth is.

COST OF PRODUCTION.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Coal	£2,622	·64d.	£3,798	·74d.	+·10d.
Oil, waste, water, and engine room stores	1,000	·25d.	920	·18d.	−·07d.
Salaries and wages incurred in generation and distribution	2,358	·58d.	2,071	·41d.	−·17d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,601	·39d.	1,785	·35d.	−·04d.
Works' costs	£7,581	1·86d.	£8,574	1·68d.	−·18d.
Rent, rates and taxes	397	·10d.	473	·09d.	−·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c,	965	·23d.	1,223	·24d.	+·01d.
General establishment charges, stationery and printing, law charges and insurance	225	·05d.	239	·05d.	...
Sundry lamps and materials	194	·05d.	260	·05d.	...
Total costs	£9,362	2·29d.	£10,771	2·11d.	−·18d.

The profit statement is complicated in the accounts by the balances brought forward. Taking these into consideration, the net revenue account shows a payment of £1,475 to reserve fund and a figure of £1,000 as the "sum to be applied to the local rate."

PROFIT STATEMENT.

	1897.	1898.
Interest on loans and overdrafts	£3,293	£4,017
Sinking fund for repayments	2,794	3,610
Net profit carried forward	794	2,125*
Gross profit	£6,881	£9,752

* £1,000 of this sum is "applied to the local rate" and the difference is made up to £1,475 (by the brought forward surplus of 1897 undisposed of) which sum is paid to reserve fund.

CITY NOTES.

The Charing Cross and Strand Electricity Supply Corporation, Limited.

AN extraordinary general meeting of this corporation was held at St. Martin's Town Hall on Thursday last week, Mr. W. F. Fladgate, the chairman, presiding.

The CHAIRMAN moved the confirmation of the following resolution, which, says the *City Press* report, was adopted at the extraordinary general meeting held on Tuesday, 24th ult.:—

(1) That the capital of the company be increased to £800,000 by the creation of 80,000 new ordinary shares of £5 each, and 60,000 new preference shares of £5 each, and that there be attached to such preference shares the right to a fixed cumulated preferential dividend at the rate of 4½ per cent. per annum on the

capital for the time being paid up thereon, and the right in a winding up to rank for return of capital in priority to the ordinary shares for the time being in the company's capital, but without any further right to participate in profits or assets, and that such preference shares do rank, both as regards dividend and capital, *pari passu* with the existing 20,000 preference shares of £5 each, and with any further like preference shares hereafter created, but so that the total amount of the preference shares in the capital of the company so ranking shall not, without the consent of a general meeting of the company, exceed the nominal amount of the ordinary shares for the time being issued. (2) That the draft new regulations entituled Articles of Association submitted to this meeting be, and the same are hereby adopted as the regulations of the company at the exclusion of and in substitution for all the existing regulations thereof.

Apart from the City order, said the Chairman, and from the works which had to be carried out for the purpose of complying with the provisions of that order, it would have been necessary for them to create new capital in order to work their existing old districts of St. Martin's, Strand, Holborn, and St. Giles's. The speaker then referred to the growth of their business in those districts, and to the fact that the competition of rival companies necessitated expenditure of money upon works and mains. They therefore proposed to increase their capital.

Mr. Glasier seconded, and the resolution was adopted.

The Chairman afterwards moved:—

That the proposal made to this meeting for the working as a separate undertaking of the undertaking constituted by the City of London Electric Lighting Order, 1899, and confirmed by Parliament, be and the same is hereby approved, and that the directors be and they are hereby authorised to take steps for the incorporation of a new company, in accordance with the said proposal, and to enter into an agreement with such new company, when incorporated, in the terms of the draft submitted to this meeting, and to carry such agreement into effect with such, if any, modifications as they may from time to time think expedient, and accordingly to subscribe money for the purposes of the said City undertaking, and to make advances as therein provided, and that the directors be authorised to take office as directors of such new company, and to hold the same in conjunction with their directorships in this company.

Commenting upon this motion, the Chairman said with reference to the City undertaking that they proposed to form a company which would do the necessary work of laying the mains and building the proposed station. That company would have the necessary funds lent to it in the first instance by the Charing Cross and Strand Company, who would receive interest at the rate of 4 per cent. per annum. He concluded by showing that the ultimate destination of the whole of the profits on the ordinary share capital of the construction company would go into the pockets of the Charing Cross Company. In the event of the purchase by the City in 14 years' time the bonus of 10 per cent. which they would have to pay would also accrue to the Charing Cross Company.

The West India and Panama Telegraph Company, Limited.

The directors' report for the half-year ended December 31st, 1899, to be submitted to the meeting to be held on May 30th, 1900, reads as follows:—

The directors submit the accounts for the six months ended December 31st, 1899. The amount to credit of revenue is £22,643 14s. 7d. against £51,937 16s. 7d. for the corresponding half-year of 1898, and the expenses have been £21,432 18s. 3d. against £24,443 15s. 6d., leaving a balance of £1,211 1s. 4d. This disappointing result has caused much concern to the directors. It must be borne in mind that the revenue for the corresponding period of 1898 was abnormally large in consequence of the Spanish-American war. Since the conclusion of the war the traffic has resumed its normal character, and owing to its being carried at lower rates than formerly, and there being no compensating increase of business, the company is now feeling the full effects of the reductions made in the message tariffs. The directors regret that, notwithstanding the reduced rates, coupled with the efforts which it was understood Her Majesty's Government were making to stimulate the trade and enterprise of the West Indies, the result of the half-year's working is so discouraging. It will be seen that the total profit upon the share capital of £1,275,590 for the half-year is only £1,211 1s. 4d. To this amount there is to be added £3,021 8s. 2d. interest on investments which, in compliance with the views expressed by the shareholders at the last half-yearly meeting, has been credited to revenue, instead of to reserve as has hitherto been done, making with £379 14s. 2d., brought forward from last account, a total of £4,612 3s. 8d. to the credit of revenue. As it requires £11,769 12s. to pay the half-yearly dividends on the first and second preference shares, the amount available, even with the interest on investments and the small balance brought forward, is insufficient to meet these dividends by £7,157 8s. 4d. Having regard to the fact that one of the objects of the reserve fund is the equalisation of dividends; that the dividends on both classes of preference shares are cumulative, and that there is a substantial increase over cost in the value of the investments, the directors recommend on this occasion the payment of dividends by drawing on the reserve fund; and they also recommend that a dividend of 1s. per share (free of income-tax) be paid on the ordinary shares. To meet these dividends the sum of £12,000 has been transferred from the reserve, leaving £279 6s. 8d. to be carried forward. The board regret to have to report that, notwithstanding the reductions of tariff made by the company, the colony of Barbadoes has reduced its subsidy from £2,500 to £1,500 for the current year. The directors regretfully express the opinion that low rates for West Indian telegraphic communications cannot be maintained without the financial assistance of the Government. In view of the discouraging circumstances, they have, therefore, recently addressed the Secretary of State for the Colonies, pointing out the present position of the company, and asking for Imperial aid, without which, it appears to the board, that the maintenance of the telegraphic communications of the West Indies, in the interests of commerce, of Her Majesty's Government and the Colonies, will be imperilled. A reply from the Colonial Office is anxiously awaited. In accordance with the articles of association, Walter Bishop Kingsford, Esq., retires at this meeting, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

Oswestry Electric Lighting and Power Company, Limited.

The following is the report of the directors:—"The accounts for the year 1899, show continued progress. The gross profit for the year amounts to £318 8s. 2d., which, with £8 0s. 1d., brought forward from 1898, makes an available balance of £326 8s. 3d. Besides providing for depreciation, in accordance with the scheme approved by the Board of Trade, the directors have added a further sum of £60 to the reserve fund, which they are charging with the cost of a renewal and extension of battery cells, and have also written off £12 0s. 4d. from the preliminary expenses, a net divisible balance of £254 7s. 11d. remaining. The directors recommend the declaration of a dividend at the rate of 4 per cent., leaving £20 9s. 2d. to be carried to next account.

Prospectuses.

Several prospectuses of electrical interest have been before the public during this week. The Thames Ironworks, Shipbuilding and Engineering Company closed the list yesterday, Thursday, for an issue of 100,000 "B" 6 per cent. preference shares for the purpose of increasing the working capital so as to cope with the growing business.

The list closes to-morrow in the issue of 5½ per cent. preference shares in Meldrum's, a firm whose name is quite familiar to electrical engineers. Meldrum Brothers, Limited, has a share capital of £125,000, in 50,000 5½ per cent. cum. pref. shares of £1 each and 75,000 ordinary shares of £1. The company will purchase and carry on the business of Meldrum Brothers, engineers, manufacturers of forced draught furnaces, mechanical stokers and other engineering specialities. The business is stated to have been carried on successfully for the past 14 years by the present partners at the Atlantic Works, Manchester, and Victoria Street, Westminster, with numerous branches. It is intended that the company shall take over the business from January 1st last, and acquire the whole of the machinery, plant, stock-in-trade and assets, which stand in the books at £33,226, and discharge the trade liabilities, stated to amount to £11,184. The profits for the last three years are put at £8,223, £8,805, and £8,943, an average of £8,657 per annum. The vendor directors will continue to act as managers for at least five years. The vendors, who are the promoters of the company, have fixed the purchase price of their business (including the assets, patents, patent rights, trade marks, goodwill, and all contracts) at £60,000 (£50,000 in fully-paid ordinary shares and the balance in cash). The 5½ per cent. cumulative preference shares are offered for public subscription, the balance of the ordinary shares being retained for future issue.

The third prospectus is that of the British Electric Plant Company, Limited, but this, we understand, is purely a Scottish concern, and is not being advertised for public subscription in England. We quote the following extracts from the prospectus:—"This company is being formed to establish and carry on works in Scotland for the manufacture of electrical engineering plant of all descriptions, but principally dynamos, motors, transformers, rotary converters, and accessories connected therewith. It will also undertake an electricity bulk supply business, worked in conjunction with its own electric lighting and power plant. It is intended to lay out the works on the most approved modern lines, to ensure the carrying forward, with a minimum of handling, of all material continuously from the point of entry in the raw state to the place of loading as finished machinery, and the general plan of the works has been designed with the view to facilitate economical extension when necessary. An important feature will be that of standardisation in every department, by the adoption of an adequate number of stock sizes in suitably graduated capacities, so that while all reasonable requirements will be met, there will be little departure from the regular patterns. In this way full advantage will be secured of special labour-saving tools, patterns, and methods of construction. A site for the works has been secured just outside Alloa. In view of the rapid development of the East Coast coalfields with the consequent probable demand for electrical equipment, and the abundant supply of labour in the district, Alloa offers advantages for the purposes of this company which cannot be obtained in the same degree elsewhere. The directors have also made a provisional contract with the Commissioners of the Burgh of Alloa (who already possess the necessary Parliamentary powers) for the bulk supply of electricity for lighting and other purposes within the burgh. The cost of erecting and equipping the works with the best types of machinery, plant, and tools is estimated to be about £45,000, so that with the present issue of £75,000 of capital, £30,000 will be available as working capital, and this is considered ample for the purpose. The company will pay no promotion money. There are no vendors' profits. None of the shares will be underwritten. The directors have secured the services as managing director of Mr. Wilfrid L. Spence, Assoc.M.I.C.E., under a five years' agreement, upon favourable terms. The directors subscribe for one-third of the present issue. The directors are J. G. Stewart, T. E. Lander, W. R. Dick, and W. L. Spence. Mr. T. E. Moore is secretary *pro tem.*, and the registered office is 154, St. Vincent Street, Glasgow. The capital of the company is £100,000, in £10 ordinary shares, of which £75,000 is offered for subscription.

British Aluminium Company.

The directors' report for 1899, presented at the meeting held on 24th inst. (Thursday), states that there is a gross profit of £41,520, and after payment of all general expenses, repairs and maintenance and interest, there remains £14,236 available for distribution. As there are still arrears due on the cumulative preference shares, for the time when the works were under construction and the company was earning no profits, the directors now recommend the payment of the cumulative 7 per cent. dividend on the preference shares up to October 1st, 1897, and that the balance be carried forward. In order to carry through new arrangements for extending the operations of the company, and also to provide for the natural development of the business, further capital, it is stated, is needed, and the directors

recommend the creation of 10,000 "A" preference shares of £10 each, bearing cumulative interest at 6 per cent. The necessary resolutions were to be proposed at an extraordinary meeting following the general meeting, and, if passed, it was proposed to offer 5,000 of these shares to the present shareholders in proportion to their holdings.

Callender's Cable and Construction Company.

The report for 1899 states that the balance, including £6,212 brought forward, is £48,179. From this must be deducted prior interest and dividends and depreciation, amounting to £14,957, leaving available £33,222. This it is proposed to deal with as follows:—Payment of dividend to the holders of original ordinary shares at the rate of 10 per cent. per annum, being 10s. per share, whereof 5s. was paid as an interim dividend, £10,000; payment of a bonus of 5s. per share, £5,000; to reserve, £10,000, leaving to be carried forward £8,222. Owing to the increased business, the directors state that it is necessary to augment the working capital of the company, and they propose to issue 20,000 new preference shares of £5 each under the powers given to them last year. The meeting of the company was held yesterday (Thursday) afternoon.

Castner-Kellner Alkali Company, Limited.

The report for the year ended March 31st states that the result of the trading is a gross profit of £59,486, out of which £11,273 has been expended in repairs, renewals, and special improvements of the working plant. The net profit is £45,398, which, with £5,342 brought forward, makes £50,740. An interim dividend at the rate of 8 per cent. per annum has been paid for the six months ended September 30th amounting to £12,000, and debenture and loan interest, £6,694, has been paid, leaving an available balance of £32,045. The directors propose that a further dividend at the rate of 8 per cent. per annum be paid for the six months ended March 31st.

Isle of Man Tramways and Electric Power Company.—The *Financial Times* Douglas correspondent says that the report of Messrs. Turquand, Youngs & Co., of London, on the financial position of the Isle of Man Tramways and Electric Power Company, Limited, deals at length with the unsatisfactory state of the company, and comments strongly on the conduct of the company's affairs for some years past. It is stated that dividends amounting to £15,000 have been paid out of capital, and that there is no title to the Snaefell Mountain Railway undertaking. Mention is also made of the circumstances attendant upon the placing of a large order for Bonnor waggons, an American invention.

Stock Exchange Notices.—The Stock Exchange Committee has appointed a special settling day as under:—Wednesday, May 30th, British Electric Traction Company, Limited—Further issue of £150,000 5 per cent. perpetual debenture stock, and has ordered the undermentioned to be quoted in the Official List:—Blackpool and Fleetwood Tramroad Company—Further issue of 3,000 shares of £10 each, fully paid, Nos. 12,001 to 15,000. British Electric Traction Company, Limited—Further issue of £150,000 5 per cent. perpetual debenture stock.

The Western Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended March 31st, 1900, and payable on June 22nd. The transfer books will be closed from June 15th to 21st, both days inclusive.

Telegraph Manufacturing Company, Helsby.—A final dividend is announced at the rate of 14 per cent. per annum on the ordinary shares to March 31st, making 10 per cent. for the year, together with a bonus of 2 per cent. £17,500 is carried to reserve, and about £5,000 forward.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending May 19th, 1900, were £526 0s. 0d.; receipts for corresponding period, 1899, £324 17s. 7d.; aggregate for half-year to date, £5,110 6s. 4d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 19th, 1900, were £2,763 17s. 11d.; corresponding period, 1899, £2,863 13s. 9d.; decrease, £99 15s. 10d.

The City and South London Railway Company.—The receipts for the week ending May 20th, 1900, were £1,339, ditto May 21st, 1899, £1,079; increase, £260. Total receipts for half-year, 1900, to date, £24,963; corresponding period, 1899, £21,321; increase £3,642. Miles open May 20th, 1900, 8¾; May 21st, 1899, 8¾.

The Dover Corporation Tramways.—The receipts for the week ending May 19th, 1900, were £173 8s. 7½d.; May 20th, 1899, £160 2s. 7d.; increase, £13 6s. 1½d. Total receipts to date, 1900, £3 194 7s. 5d.; corresponding period, 1899, £3,046 2s. 6d.; increase, £148 4s. 11d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,944; 1899, 4,104. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, May 18th, 1900, were as follows:—D. U. T. Co., horse cars £52 6s. 1d.; ditto, electric cars, £3,247 3s. 4d.; D. S. D. Co., electric cars, £759 9s. 2d.; total, £4,058 19s. 4d.; corresponding week last year—D. U. T. Co., horse cars, £1,915 19s. 7d.; ditto, electric cars, £1,064 13s. 3d.; D. S. D. Co., electric cars, £744 3s. 6d.; total, £3,724 16s. 4d.; increase, £334 3s. 0d. Aggregate to date, £80,276 6s. 10d.; aggregate to date last year, £67,190 9s. 6d.; increase to date, £13,085 17s. 4d. The mileage worked is 42 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 20th, 1900, amounted to £1,476; corresponding week last year, £1,395; increase, £81. Total traffics from January 1st to date, £28,228; corresponding period 1899, £27,023; increase, £1,205. Miles open, 6 57 chains.

The South Staffordshire Tramways Company.—The receipts for the week ending May 18th, 1900, were £650 17s. 9d.; May 19th, 1899, £596 2s. 3d. Aggregate receipts for 20 weeks, £12,928 18s. 9d.; last year, £12,316 12s. 3d.

STOCKS AND SHARES.

Wednesday Evening.

The relief of Mafeking failed to bring the anticipated burst of buying into Stock Exchange markets. The public still stands steadily aloof, refusing to invest its money or to speculate with it. A new edition of the National War Loan is again talked about, while the various foreign complications which are rumoured all tend to keep people away from Capel Court. The changes which we have to chronicle are few and far between. Telegraph securities show an upward tendency, but electrical supply, railway and miscellaneous investments hardly show an alteration of 2s. 6d. in the whole list.

Telegraph Manufacturing exhibit a rise of 30s. per share upon the excellent dividend recently announced. The distribution at the rate of 14 per cent. per annum makes 10 per cent. for the whole year, and there is a bonus of 2 per cent. The company is now occupying a strong position, and we should not advise readers who bought them on our consistent recommendations to part with them yet, despite the handsome profits now obtainable. Anglo-American Telegraph issues are better, although the wave of depression in the general markets last Tuesday deprived them of some of their regained strength. Cuba Telegraph Ordinary and Preference form the exception to the firmness of the telegraph department as a whole. The reduction of the dividend from 8 per cent. to 6 per cent., however, is quite natural, considering that the company had no war receipts to swell its coffers last year. Eastern Extension Debenture stock has recovered one of the two points which it shed last week, but the issue of new shares, announced by us a week ago, has not materially affected the price of the old, although the latter will benefit by a bonus of about 6s. 6d. per share. Globe Telegraph Ordinary have been picked up for investment purposes by those who are impressed with the hardness of telegraph securities. Western Telegraph shares are being bought on the strength of the last report.

We regret to notice that Messrs. Simn, Newman & Co. are again playing the old game of puffing Hampstead electric shares. The boldness of this firm is beyond comprehension, for, as our readers well know, the Hampstead Electric only a fortnight ago passed the dividends on both its Ordinary and Preference shares.

It has now been declared publicly that the Charing Cross and Strand Company is well on its way to the City, some 3,000 lamps being already in use, which, by the way, compares with about 160 times as many supplied by the City of London Company. We may, therefore, take it that the new baby of the Charing Cross Company will not be long in making its appearance. Rumour suggests a quarter of a million as likely to be the capital of the coming concern; we shall be astonished if it is not at least two or three times as much as that. Westminsters are unchanged, the coming bonus in the shape of new shares failing to stimulate the price, which had already been put up some weeks ago in anticipation of the scheme. City of London shares are finding supporters again, the company's cause being championed by some who declare that the directors will be able to cope successfully with any competitors who may enter the field.

The opening of the electric section on the Metropolitan District Railway was accompanied by a fall in the price of the stock, which now stands at 29½. It is, of course, too early to predict with any accuracy how the new traction will pay; that it will be a hundredfold more clean, comfortable, and healthy, no one can doubt, but it remains to be seen whether these attractions will be augmented by financial ones. Metropolitan Consolidated stock has declined to 106. Great Northern and City "A" Preference at 4, are unaltered, and there is no change to record in the prices of the other Electric Railway stocks and shares.

Some time ago we gave details of a new electrical tramway which was suggested for Havana. We may now observe that the construction of the line is proceeding satisfactorily, and the mileage has been raised from 27 to 36 miles at the request of the War Office in Cuba. The capital of the constructing syndicate has accordingly been increased, and now stands nomically at six million dollars.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, May 16th.	Closing Quotation, May 23rd.	Business done during week ended May 23rd, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	100⅜	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	62 — 65	62 — 65	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	114 —115	114½—115½	115½	114⅜
3,062,240	Do. do. Deferred...	Stock	...	18s. %	£1 7s	13½— 14	13⅜— 14¼	14 1/16	13 15/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	...	2½— 3½	2½— 3½	2⅜	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	103½	102½
16,000	Cuba Telegraph	10	7 %	8 %	7 %	8½— 9½xd	7½— 8½xd	9⅜	7⅝
6,000	Do. 10 % Pref.	10	10 %	10 %	...	18½— 19½xd	17 — 18 xd	17½	17
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	101 —105%	101—105%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	11½— 12	11½— 12	11 15/16	11⅞
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	150 —155	150 —155	153½	151
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	98 —101	98 —101	99	98
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	111 —116	111 —116	114	113
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	15¾— 16¼	15⅝— 16¼	16¼	16
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	100 —103	100 —103	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	111 —116	112 —117	112½	112
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	101¾	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	100 -103	100 —103%	101	...
180,227	Globe Telegraph and Trust	10	4½%	5⅛%	5½%	11½— 11¾	11½— 11¾	11⅝	11½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15¼ — 15¾	15⅝	1 1/8
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	12½%	...	32 — 34	32 — 34	34	...
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	52 — 56 xd	53 — 57	55⅝	53¼
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	105¼	..
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅛	¼— ⅛	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	⅜— 1	⅜— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅜— 5⅛	4⅞— 5⅛	5	4⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	13⅞	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5 — 5¼	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	96 — 99	96 — 99	98½	97
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	1 1/16— 1 1/16	1 1/16— 1 1/16	1	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	102 —105	102 —105	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7½ — 8½	7½	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	125	...
58,000	United River Plate Telephone	5	5 %	6 %	6 %	4⅜— 5⅛	4⅜— 5⅛	...	...
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4⅜— 5⅛	4⅜— 5⅛	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	97 —100	97 —100	...	...
80,008	West Coast of America, Nos. 1—80,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14½— 15	14⅝— 15¼	15⅛	14⅝
75,090	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	105 —108	105 —108	105	...
88,321	West India and Panama Telegraph	10	2 %	2 %	...	⅞— 1½	⅝— 1	1	⅞
84,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	9½— 9¾	9 — 9½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	7 — 8	7 — 8	...	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	...	..

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	...		8½— 9½	8½— 9½	..	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	8½ - 9¼	8½— 9⅜	9⅛	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5¼— 6	5¼— 6	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	6 %	6 %	6 %	6½— 7½	6½— 7½	...	...
150,000	Do. do. do. % Deb. Stock Red....	Stock	4½%	...	...	108 —111	108 —111	...	..
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ..	10	10 %	6 %	4 %	10 — 11	10 — 11	10 5/16	10⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	12⅜	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	4 %	9½— 10½	9½— 10½	9⅝	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13	12⅜	...
200,000	Do. 4½% Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	109 — 112	109 —112	111½	111
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock ...	100	...	...	...	01 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	8	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. 6 % Pref.	5	...	6 %	...	4 — 4½	4 — 4½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	13½ - 14½	13½ - 14½	14¼	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	114 —117	114 —117	...	..
220,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	96 — 98	98	97
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15½— 16½	15½— 16½	...	.
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	15¼	15⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2⅖	2 — 2¼	...	...
50,000	Do. Do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	4 — 4½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	12 %	12 %	13 %	14½— 15½	14½— 15½	14 13/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation May 16th.	Closing Quotation May 23rd.	Business done week ended May 23rd, 1900. Highest	Lowest.
		‡							
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2⅜— 3¼	2⅜— 3¼	3 1/16	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
80,000	British Electric Traction	10	...	6 %	...	15½— 16½	15½— 16½	...	...
59,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12½	...
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	124 —127	124 —127	125½	125
45,000‡	†British Electric Works Co., Ord. £1 shares, 50,001—95,000	...	...	...	...	⅞— 1	⅞— 1	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	15/16— 15/16	15/16— 15/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	99 —101	99 —101	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6 — 6½	6 — 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 %	5 %	...	1⅞— 2	1⅞— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2⅛	2 1/16
125,000‡	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	108 —113	108 —113	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	103 —105	103 —105	103⅜	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½%	15 %	15 %	14½— 15½	14½— 15½	...	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —116	112 —116	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10 7/16	10⅜
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5⅛	4⅜— 5⅛	5¼	5
71,447	Do. do. Def. do.	5	...	...	...	5 — 5⅛	5 — 5⅛	5 1/16	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	61 — 64	61 — 64	63	...
37,500	Do. do. Ord. shares, Nos. 22,501 to 60,000	10	...	...	...	5½— 6½	5½— 6½	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	...	3½— 4	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 103	100 —103	...	...
199,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 %	6 %	...	3½— 4¼	3½— 4¼	4¼	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	93 — 95	93 — 95	91½	93½
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2⅛	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	...	2⅜— 3¼	2⅜— 3¼	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
9,600‡	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	13½— 14½	13½— 14½	14¼	13¾
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5½— 5⅝	5½— 5⅝	5¼	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21¼	...
800,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3⅜%	8⅞— 9	8 5/16— 8 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13½— 13½	13½— 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 38	34 — 38	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10 — 11	11½— 12½	12	10⅞
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½— 6	5½— 6	5⅜	...
540,000‡	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	100 —103	100 —103	101½	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid. ⅜—½ xd.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17½—18½.
Do. do. Pref. (£10 pd.), 10¼—10⅜.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅛—8⅛. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 18.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (January 25th, 1900).

MARKET QUOTATIONS, Wednesday, May 23rd.

CHEMICALS, &c.	This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a ,, Nitric .. .. .. per cwt.	23/-	23/-	..
a ,, Oxalic .. .. .. per cwt.	32/-	32/-	..
a ,, Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) .. per ton	£94	£94	..
a ,, ,, ... per ton	£91	£91	..
a Bleaching powder .. .. per ton	£7	£7	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a ,, (50/90 %) .. .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26	£26	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a ,, White Sugar .. .. .. per ton	£31	£31	..
a ,, Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	4d.	4¼d.	¼d. dec.
a ,, Caustic (75/80 %) .. per ton	£94	£94	..
a ,, Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a ,, Recovered .. .. per ton	£5 10	£5 10	..
a ,, Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£10 15	£10 15	..
a ,, Crystals .. .. .. per ton	£3	£3	..
a ,, Bichromate, casks .. per lb.	3¼d.	3¼d.	¼d. dec.
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£294	£294	..
b ,, Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£80 to £150	£80 to £150	..
c Brass (rolled metal 9" to 12") basis per lb.	8½d.	8½d.	..
c ,, Tube (brazed) .. .. per lb.	10½d.	10½d.	..
c ,, ,, (solid drawn) .. per lb.	9d.	9d.	..
c ,, Wire, basis .. .. per lb.	8½d.	8½d.	..
c Copper Tubes (brazed) .. .. per lb.	11½d.	11½d.	..
c ,, ,, (solid drawn) .. per lb.	11½d.	11½d.	..
g Copper Bars (best selected) .. per ton	£86 to £87	£87	dec.

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
g Copper Sheet .. .. .. per ton	£86 to £87	£87	dec.
g ,, Rod .. .. .. per ton	£86 to £87	£87	dec.
e ,, (Electrolytic), Bars .. per ton	£92	£92	..
e ,, ,, Sheets.. per ton	£92	£92	..
e ,, ,, Rod .. per ton	£85	£85	..
e ,, ,, H. C. wire per lb.	9¾d.	9¾d.	..
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f ,, Sheet .. .. .. per lb.	5/-	5/-	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	8/- to 8/6	8/- to 8/6	..
h India-rubber, Para fine .. per lb.	3/11 to 4/-	4/2 to 4/2½	dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i ,, Pig (Cleveland warrants) per ton	73/8	74/1½	5½d. dec.
i ,, Forgings, according to size per ton	From £11	From £11	..
i ,, Scrap, heavy .. .. per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire galvanised No. 8 .. per ton	£13 10	£13 10	..
g Lead, English Ingot .. .. per ton	£16 15 to £17 2 6	£17 2 6	dec.
g ,, ,, Sheet .. .. per ton	£18 10	£18 10	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. .. per bottle	£9 10	£9 10	..
d Mica (in original cases), small per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, r'l'd str'p & sheet per lb.	From 1/3	From 1/3	..
o Platinum .. .. per oz.	£3 12	£3 12	..
p Silicium Bronze Wire .. .. per lb.	10¾d. to 1 1	10¾d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15 to £40		..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£140 to £141	£138 to £139	£2 inc.
g ,, foil .. .. per lb.	1/9	1/9	..
n ,, wire Nos. 1 to 16 .. .. per lb.	1/9	1/9	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	8½d.	8½d.	..
j ,, Best Flax, 6 lea. .. per lb.	6d.	6d.	..
j ,, Hemp, 8 ply 10 lbs. .. per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove .. per ton	£14	£14	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£27 5 nett.	£27 5 nett.	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Tod.
i Messrs. Balling & Lewe.
j Messrs. Henry C. Lee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

ON DISTANT ELECTRIC POWER TRANSMISSION.

By Prof. George Forbes, F.R.S., Member.

(*Paper read April 26th*, 1900.)

(*Concluded from page* 852.)

Another way of working the booster system is to add to the distance already covered a new section of the same length as previous ones, with the current density calculated by Lord Kelvin's law. In this case the cost of power must include the cost of copper up to the commencement of the new section.

Table V.—100 Miles; 10,000 Volts. Eight Sections of different Current Densities.

Efficiency.	Inefficiency.	Tons copper per H.P. delivered.
·53	1·9	·396
·50	2·0	·348
·45	2·2	·330
·42	2·4	·303
·37	2·7	·273
·31	3·2	·241
·23	4·3	·207
·13	7·8	·141

We may start with one section and with power costing nothing. In this case Kelvin's law gives the economical efficiency = 2 (see my paper before the Society of Arts, November, 1898). The weight of copper for this section per kilowatt delivered $= 4 \times 1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2$. In any other section, the n^{th}, let

e_n be inefficiency of that section.

$1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2 c_n$ be weight of copper for " "

E_n be accumulated inefficiency of n sections.

$1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2 C_n$ be accumulated weight of copper.

(In Table VI. I call c_n and C_n the copper factor.)

$$\text{Then } e_n = 1 + \frac{1}{\sqrt{c_{n-1} + 1}}; \quad c_n = \frac{e_n^2}{e_n - 1}$$

$$E_n = e_1 \cdot e_2 \ldots e_n; \quad C_n = e_n C_{n-1} + c_n.$$

Table VI. gives the values of these quantities for 24 sections of equal length, uncorrected for capacity and self-induction.

If now we wish to use this table for other cases where the cost of power is C_r, which corresponds in Tables VI. to an inefficiency E_r; then the economical inefficiency, say, for eight sections, is $\frac{E_r + 8}{E_r}$ and the economical weight of copper per kilowatt delivered is $1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2$. $(C_r + 8 - C_r)$. In this way Table V. has been computed.

Tables I. to VI. embody some of the best results of my study of the booster method from the year 1894 up to to-day. The curves on fig. 2 show the tons of copper required for each horse-power delivered

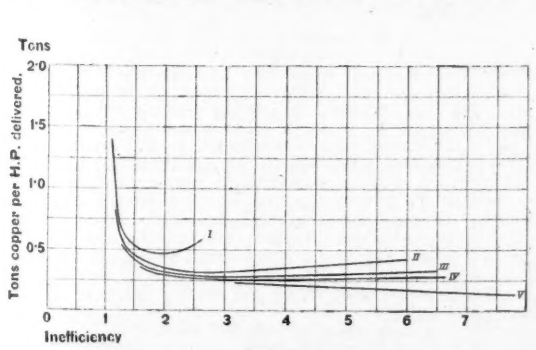


Fig. 2.

at different inefficiencies. It will be seen from them that by the booster method I am able to reduce the weight of copper (by putting in more turbines and dynamos) in some cases to less than one-half of what was possible by the old system.

The chief advantage of using boosters is to save copper at the cost of power generated, where the latter is cheap, and the distance very great. In a paper before the Society of Arts in November, 1898, it was shown that in the ordinary method of working there is no saving of copper when the efficiency is below 50 per cent. But if we wish it, we can save copper still farther by making the efficiency still lower, and using the method now indicated.

Fig. 3 explains the action of boosters (1) for single or two-phase, (2) for continuous current, (3) for three-phase. I believe that Mr. Gisbert Kapp was the first to construct an alternating current booster as here shown.

Mr. Scott, of Pittsburg, is the only person I know of who has published anything bearing on this; but his published statements are arithmetically erroneous, and so misleading, and he does not appear to have noticed the possibility of being able to save copper by reducing the efficiency below 50 per cent.

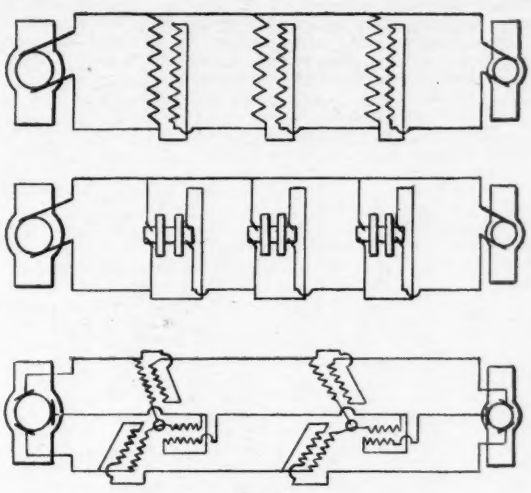


Fig. 3.

Table VI.

Section.	Efficiency of section.	e_n Inefficiency of section.	c_n Copper factor for section.	E_n Accumulated inefficiency.	C_n Accumulated copper factor.
1	5000	2·0000	4·0000	2·000	4·000
2	·6909	1·4472	4·6832	2·894	10·472
3	·7721	1·2952	5·6820	3·749	19·245
4	·8181	1·2223	6·7223	4·582	30·245
5	8482	1·1789	7·7687	5·402	43·425
6	8696	1·15 0	8·8147	6·212	58·754
7	8854	1·1294	9·8601	7·016	76·217
8	8978	1·1138	10·901	7·815	95·792
9	·9078	1·1016	11·939	8·608	117·463
10	9158	1·0919	12·976	9·4°0	141·226
11	·9226	1·0839	14·011	10·188	167·091
12	9284	1·0771	15·042	10·974	195·012
13	9334	1·0714	16·071	11·757	225·001
14	·9376	1·0665	17·099	12·539	257·059
15	·9414	1·0623	18·128	13·320	291·198
16	·9447	1·0585	19·152	14·100	327·382
17	9477	1·0552	20·177	14·878	365·627
18	9504	1·0522	21·199	15·654	405·909
19	·9527	1·0496	22·222	16·431	448·265
20	·9549	1·0472	23·244	17·207	492·664
21	·5969	1·0450	24·264	17·980	539·094
22	·9588	1·0430	25·281	18·754	587·551
23	·9604	1·0412	26·300	19·527	638·060
24	·9619	1·0396	27·322	20·300	690·652

Induction Factors and Phase Rectifiers.

The low power factor of induction motors, which lies commonly between 0·6 and 0·8, must be carefully taken into account when designing any power scheme where these are used. Synchronising motors can be adjusted so as to be without either lag or lead. But they have not been so largely adopted as they might have been but for the necessity of this adjustment. The Oerlikon Company have used synchronous motors, doing no work, in parallel with the inductive load to furnish what has been called the wattless current. In this case the synchronous motor is excited so as to act as a condenser, and is placed at the receiving end of the line. There are other methods by which idle synchronous motors may be used to overcome self-induction, and this becomes an important matter in long-distance transmission.

The self-induction of the line has to be taken into account, and I would have added to this paper the tables necessary for working out all the effects, and which I have used for many years, were it not that this would alter the character of the paper. Table VII. has been inserted, however, to give some notion of the magnitude of the effect, and it shows at a glance the factor by which the ohmic drop of volts must be multiplied in order to give the true drop due to induction and resistance, with different frequencies, and with different diameters and distance of wires with single-phase. Distance of transmission does not affect this factor. I ought to state that an American wire gauge is used in Table VII., only because the table was completed when I was working in the United States on the Niagara scheme.

When dealing with parts of the world free from telegraphs and telephones, the beginner is apt to lay undue stress on the advantages of using an earth return with single or two-phase transmission and overhead wires. So soon as he calculates the effects of induction, he generally finds that the benefit is not what he thought. Take the case of the Niagara-Buffalo line, with cables 0·6 inch diameter, and 30 feet above ground, and using a frequency of 25 cycles per second. The impedance is the same as with similar cables (go and return) 60 feet apart, and the factor is prohibitive.

TABLE VII.—IMPEDANCE FACTORS.

*Dia. and gauge.	Distance 6 in. Factor.	Distance 12 in. Factor.	Distance 24 in. Factor.	Distance 48 in. Factor.
Frequency f = 15				
1	1·842	2·182	2 535	2 904
¾	1·387	1·546	1 720	1 903
½	1·111	1·157	1 210	1·267
0000	1·085	1·120	1 167	1·203
000	1 057	1 081	1·108	1·137
00	1·038	1 054	1 068	1·090
0	1·0264	1·036	1·048	1·061
f = 20				
1	2 291	2·771	3 261	3 768
¾	1·624	1·863	2 116	2·378
½	1·190	1·263	1 351	1 441
0000	1 146	1 206	1·271	1·341
000	1 100	1·139	1·184	1 233
00	1·0 7	1 093	1·123	1·155
0	1·046	1·063	1·084	1·106
f = 25				
1	2 7654	3·3826	4 012	4 642
¾	1 8890	2 209	2 543	2 885
½	1 285	1 393	1 513	1·637
0000	1 222	1 306	1·399	1 498
000	1·152	1·210	1·276	1 345
00	1 103	1·142	1 187	1·235
0	1·071	1·097	1 127	1·160
f = 33				
1	3·51	4·381	5·221	6 081
¾	2·338	2 781	3 237	3 700
½	1 462	1 625	1 803	1 982
0000	1 362	1 495	1 634	1 780
000	1·252	1 344	1·445	1 551
00	1·173	1 238	1·311	1 384
0	1·121	1·165	1 215	1 268
f = 40				
1	4 2447	5 2661	6 2861	7 3302
¾	2 7520	3·3072	3 8719	4 4428
½	1 6342	1 8480	2 0726	2·3050
0000	1·5033	1 6753	1·8579	2·0480
000	1 3566	1·4808	1·6136	1·7553
00	1 2493	1·3371	1 4326	1 5354
0	1 1747	1·2345	1 3023	1·3756
f = 60				
1	6 2681	7 8194	9 3778	10 938
¾	3 9736	4 8334	5 6995	6 5696
½	2 1817	2·5365	2 9009	3 2716
0000	1·9583	2 2505	2 5527	2 8614
000	1·7002	1 9194	2·1480	2 3838
00	1·5040	1·6651	1·8352	2·0134
0	1·3593	1 4763	1·6019	1·7627

*Dia. and gauge.	Distance 6 in. Factor.	Distance 12 in. Factor.	Distance 24 in. Factor.	Distance 48 in. Factor.
Frequency f = 80				
1	8 3108	10·387	12 474	14·557
¾	5·2244	6 3840	7 5478	8 7151
½	2 7720	3 2649	3 7339	4 2722
0000	2·4577	2 8683	3 2873	3 7119
000	2 0884	2 4724	2·7249	3·0536
00	1·8011	2·0376	2 2825	2 5355
0	1 5833	1 7597	1 9451	2·1373
f = 100				
1	10 362	12·919	15 573	18·182
¾	6·4873	7 9445	9 4039	10·869
½	3 3829	4 0118	4 6474	5 2874
0000	2 9793	3·5060	4 0400	4·5787
000	2 5004	2 9078	3 3225	3·7426
00	2·1227	2·4341	2 7528	3 0794
0	1 8316	2 0679	2 3130	2 5642
f = 130				
1	13 444	16·832	20 227	23 623
¾	8 3925	10 295	12 191	14·104
½	4 3185	5·1487	5 9842	6 8233
0000	3 7828	4 4814	5 1860	5·8942
000	3 1426	3 6878	4·2487	4 7939
00	2 6316	3 0529	3 4808	3 9161
0	2 2328	2·5567	2 8898	3·2283
f = 25				
2	7·7638	10 37	12 912	15·55
1½	5 014	6 454	7 831	9 017
1	2 7654	3 3826	4 012	4 642
¾	1·889	2·209	2 543	2 885
½	1 285	1·393	1 513	1·637
0000	1·222	1 3068	1 3996	1·498
000	1·152	1 2104	1·2763	1·345
00	1·1034	1·1422	1·1876	1·235
0	1 0710	1·0973	1·1277	1 160
1	1 0478	1 0676	1 0853	1·108
2	1 0324	1 0443	1 0583	1 071
3	1·0216	1 0293	1·0384	1 048
4	1 0142	1 0191	1 0247	1·031
5	1 0094	1·0126	1 0162	1·0203
6	1 0063	1 0084	1 0107	1·0134
7	1 0042	1 0055	1·0070	1 0087
8	1 0027	1·0035	1 0045	1 0056
9	1 0018	1 0023	1·0029	1·0036
10	1 0011	1 0015	1 0019	1·0024

To find true drop in line, multiply ohmic drop by factors in these tables.

* Diameter in inches, Gauge Brown & Sharp.

CHOICE OF POLYPHASE SYSTEMS.

In choosing a polyphase system we may use two-phase, or three-phase star, or three-phase mesh. Three-phase star cannot well be used if any consumer's plant uses only one-phase, as was proved from actual trials in a paper I read before this Institution in 1893. For these cases two-phase or three-phase mesh must be used. Three-phase mesh subjects the transformers to 1·7 times the electric pressure experienced by three-phase star, or two-phase, each earthed at the centre of the electric system.

The principal advantage of the two-phase is, that the two circuits may be electrically disconnected, either always or else during tests. This facilitates the detection of troubles and gives far greater security, as I have convinced myself beyond doubt in actual practice.

It has been generally assumed that, using the same electric pressure, the three-phase system uses only three-quarters of the copper required for the two-phase. This is founded purely on the convention adopted in defining the electric pressure. In fig. 4 a three-phase star and a two-phase system are represented, each with 10,000 volts between any one wire and the middle of the electric system, which may be conveniently earthed; and the two systems represented require the same weight of copper to give the same effect (though not the same number of insulators). The volts between neighbouring wires in these cases are 17,320 with the three-phase, and 14,140 with the two-phase; yet the convention is to speak of these cases as being 17,320 with three-phase, and 20,000 with two-phase. This might be an unobjectionable convention if the trouble arising from high electric pressure was due to risks of sparks passing from wire to wire. I

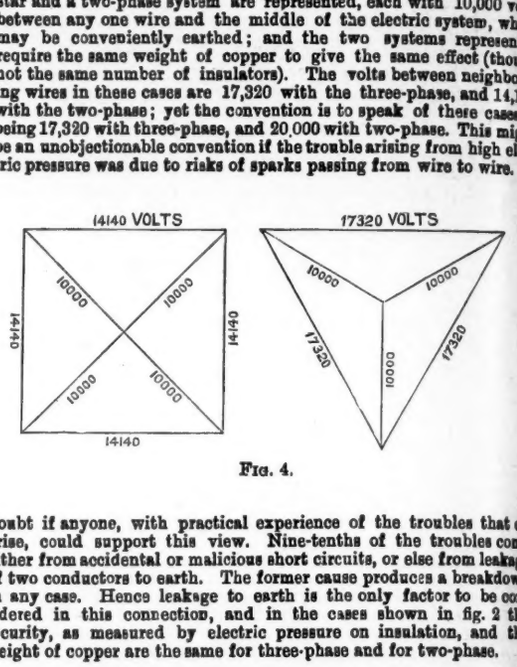


FIG. 4.

doubt if anyone, with practical experience of the troubles that do arise, could support this view. Nine-tenths of the troubles come either from accidental or malicious short circuits, or else from leakage of two conductors to earth. The former cause produces a breakdown in any case. Hence leakage to earth is the only factor to be considered in this connection, and in the cases shown in fig. 2 the security, as measured by electric pressure on insulation, and the weight of copper are the same for three-phase and for two-phase.

OVERHEAD AND UNDERGROUND CONDUCTORS.

The choice between bare overhead conductors and insulated cables underground has generally to be decided upon considerations other than economy or effectiveness. In this country insulated cables will generally be employed. In this case self-induction of the line, which we know how to compensate in any case, can be got rid of. But the effects of capacity, which are more troublesome to deal with, are much increased. The electric pressure to be selected on an underground transmission depends almost entirely on the financial side of the question regarding relative costs for insulation. The Rheinfelden plant was the first case where the electric pressure was selected solely with a desire to obtain the best economy. In almost all other cases the pressure has been chosen by rules which depend on the timidity or rashness of the engineer, and occasionally on his past experience. We have not yet reached such pressures as require account to be taken of electric air convection or brush discharge from surfaces of small radius of curvature, except for temporary experiments.

ALUMINIUM CONDUCTORS.

A few words must be said about the use of aluminium as a conductor. The weight of aluminium required is almost exactly one-half of the copper which would produce the same effect. The diameter of cable is 28 per cent. in excess of one made of copper, and the cost of insulation for an underground cable is increased in about the same proportion when we pass from copper to aluminium.

Aluminium is not a pleasant metal to deal with, but its high conductivity will make it invaluable for overhead transmission. It is true also that the weight to be supported on posts is half of copper, but the surface exposed to the wind is greater and its strength is not great. The chief drawback to its use, especially overhead, is its liability to become rotten. This defect does not exist if the metal be pure and especially if free from sodium. But exposure to the atmosphere, especially near the sea, induces deterioration. The fact that aluminium is easily oxidised ought not to condemn it. The same is true of iron and steel, and yet we do not hesitate to place structures of these metals in exposed positions. Only we paint them; so I propose that we paint or varnish our aluminium conductors wherever necessary. We have had little experience in this direction. I laid out a few hundred yards of ½-inch aluminium wire on a Scotch estate a year ago, and am watching the effects of weather.

Having now dealt almost entirely with the work of foreign manufacturers, I should like to suggest that a British type of power transmission might be worked out differing in some details from what is becoming the normal arrangement. But it would be an impertinence on my part to appear to suggest to manufacturers how best to look after their own interests. The reason why I venture to broach this question is that I notice in the many tenders that come under my notice for power transmission a tendency to crystallise the proposals and to settle into grooves which do not seem always to be the best. This stereotyped character has lately forced itself on my attention in connection with the proposed Mysore development of water power, and electric transmission over 90 miles. I received five tenders from the firms most experienced in this work in Europe and America. The most remarkable feature was their great resemblance to one another except in certain details. They all used three-phase alternating currents generated at an electric pressure between 2,000 and 3,000 volts. The units varied from 1,000 to 1,333 H.P. Three used mesh connections, and two used star connections. The frequency varied

from 25 to 40. All used separate turbines for exciters. All had turbines and dynamos on the same horizontal shaft. The electric pressure used for transmission varied from 23,800 to 30,000 volts. Three preferred oil cooling for transformers, one air-blast, and one natural ventilation. The line construction varied considerably, so did the working of the distant transformer station. It is not desirable to go further into details, but it may be said that in every case two complete and independent sets of conductors were proposed. Also the loss allowed on the line was not determined by Lord Kelvin's law, but generally on the basis of enabling the proportioning of volts to load to be capable of adjustment without altering the speed.

Most of the arrangements now mentioned are admirable, and their similarity shows that there is a consensus of opinion in their favour.

I would suggest as subjects worthy of your consideration the following points:—

1. The arrangement which suits a transmission line which is also a distributor of power does not necessarily yield the best results for a plant transmitting the whole power to a long distance.

2. The high pressure continuous current system is very suitable for certain cases as worked out at Genoa.

3. The two-phase alternating current is to be preferred over the three-phase in many cases, and especially where an earth return can be used.

4. The horizontal shaft for turbine and dynamo which is so much in vogue, might well be replaced by a vertical shaft, as at Niagara, Rheinfelden, and other places.

I should like to mention other matters, but do not consider the time opportune. Some, no doubt, will be spoken of during the discussion, and any remarks from others who have had experience of these matters will be of value. Most of what has been said in this paper has reference primarily to cases where water-power is used, and generally to countries where bare overhead conductors are permitted. But generally the same considerations have a bearing upon cases where the power is generated by steam and where the cables are underground, although the distinctive characters of the two cases are very marked. With insulated cables the cost of insulation takes away from the superiority of two over three phases except, perhaps, when a common return is used. The same cause acts against the use of aluminium in place of copper underground. Again, in cases of generating power at the coal pits, the transmission line generally becomes also a distribution line, and militates against the use of known methods for increasing the power factor. But the most important difference between an underground and an overhead transmission must be noticed, viz, that induction in one case, and capacity in the other, is the trouble that demands the most careful attention.

It has been my desire in this paper to disclaim all idea of teaching the members of this Institution anything about their profession. This is not a class room. The object of this paper is only to put down a few of the ideas about electric transmission that have occurred to me in practice during the last 10 years, and which seem to be the most important at this date to draw attention to, and to ask other men of experience in this work to tell us some of the results that they have obtained.

THE CALCULATION OF DISTRIBUTING SYSTEMS OF ELECTRIC TRACTION UNDER BRITISH CONDITIONS.

By H. M. Sayers, Associate Member.

(*Paper read May 3rd*, 1900.)

(*Continued from page* 853)

Assume that the track is single and laid with 90-lb. rails, or 180 lbs. rail per yard of track. Assuming the resistance of the rail to be 11 times that of copper of equal section, and that joints add 5 per cent. to that resistance, a mile of bonded track will have a resistance of ·0289 *w*. The interesting paper read by Mr. Parshall before the Institution on April 28th, 1898, will be familiar to all interested in this question, as it shows by examples how the chemical composition of rails, kind of bonding, and number of joints per mile has to be taken into account. Naturally the mechanical use of the rails takes precedence of their electrical functions, and hence the electrical engineer has to be thankful for what he can get. The resistance of the return as laid is usually lower than that of the rails alone, some conduction being afforded by the earth. The amount of this varies very much. Mr. Parshall has found an instance in which only two-thirds of the current returned by the rails. Weather affects it. In one case within the writer's knowledge wet weather reduced the voltage drop, and also the stray current, evidently increasing the conductivity of the non-metallic parts of the track.

But as this earth shunting of the rails cannot be foretold, the safe course is to take the resistance of the uninsulated return as that of the rails alone. To allow for possible increase of service, abnormally busy days, and bunching of cars, the limit calculated on should be, say, 5 volts, not the whole 7 volts allowed in the Board of Trade regulations. The integrated product of amperes into miles to give this drop will thus be $\frac{5}{0289} =$ 173 ampere miles. Mr. Trotter's paper of April, 1898, gives a neat and simple graphic method for showing the drop under given conditions. It can be easily applied along any section of line with a uniform service. For such a case as that under consideration, with varying services along different sections and junctions, an arithmetical process seems a little simpler. The arithmetical process is as follows:—Starting from the station, sum the product of amperes into miles until this product equals the constant corresponding to the limiting drop—*e.g.*, 173 for the case here assumed. It is at once clear that all current from cars beyond this point has to return by track feeders.

From this point start the integration afresh, and go on until the constant is again reached. At this second point the rails should be at earth potential. Recommence the summation from this second point and go on again to the constant. Then all the current due to cars between the first and third points should return to the station by a track feeder connected at the second point, and so on in succession, the even points marking feeder connections kept at earth potential, the odd points marking points of maximum D.P. above earth in the rail. This calculation applies equally to feeding points in transforming systems, so far as such points depend upon the drop in the return. It will be clear that the direction of the current must be from odd points to even points. When the terminus of a route does not correspond with an odd-numbered point, integrate the ampere miles from the last odd point forwards, and from the terminus backwards, and the point on the line where these sums are equal is the last feeding point, the potential of which may be above that of the earth by the amount corresponding to the defect in the ampere miles from the constant. This means, of course, a little lighter feeder, but the difference is usually insignificant as regards economy.

Obviously, the calculations above described will only give correct results for the distribution of traffic and current assumed. Such assumptions can only approximate to average working conditions, and it is only prudent to allow a considerable margin on the upper side in assuming the traffic, for growth and other obvious possibilities. Again, the feeding points so found may not be the best practically.

It would be better, for example, to feed the track at a junction, connecting the feeder to all the diverging roads, than at a near point indicated by calculation, which should result in excessive current density in the rails of one road. Such excessive density may damage rails and possibly cause local damage to pipes near by. The best density of current for track feeders is determined exactly as for trolley feeders, giving the wasted watts their proper rate as "boosted watts." Unboosted track feeders are of no commercial value, as Mr. Parshall distinctly showed in the paper before referred to. In our example, the density for boosted feeders has already been shown to be 306 per square inch, giving a drop of 13·75 volts per mile run. From these figures the feeder sections and losses, and sizes of boosters, can be readily applied to suit the feeding points found in the manner above explained. The detailed calculation for track feeders is given in Appendix No. 4, and all track feeders needed on this system are shown in diagram B. The list of them is as follows:—

No.	Route.	Length.	Current	Sections. sq. in.	Tons Cu.	Value.	Drop.	Loss in watts.
1	T E'wards	2·97	120	·39	10·5	£1,585	41·6	5,000
2	T W'wards	4·00	273	·89	32·3	4,877	60·24	17,000
3	T to J	2·15	127·5	·415	8·1	1,223	32·4	4,200
		9·12			50·9	£7,685		26,200

Boosters to a total capacity of, say, 36 KW. would be needed, costing, say, £15 per KW. or £540. Annual charges at 15 per cent. on these amount to £81. As before the interest on the mains is rather less than the cost of power, the assistance of the rails coming in to reduce it. We then get on the track side:—

Loss in feeders, 26·2 KW., worth annually	£600
Interest on cables, 7 per cent. on £7,685	538
Charges on boosters	81
Total	£1,219

Adding this to the cost on trolley side, £1,291, we get a total of £2,510.

This equals ·266d. per unit delivered to the cars, making its cost there 1·016d.; and the total annual generating and distribution costs, as far as here considered, £9,936.

There will be 25·645 miles of cable laid in 12·025 miles of trenching, weighing 104·15 tons, to the value of £15,853 in addition to the cost of laying them. Boosters will cost £740.

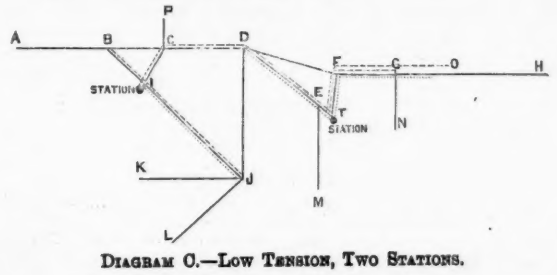


Diagram C.—Low Tension, Two Stations.

Trolley feeders — — — Track feeders .....
Limits as in Diagram B.

The electrical efficiency of the whole system will be about $\frac{427·5}{499} = 86$ per cent. or a trifle higher. These figures show very strongly that a single low-tension station for this system is very expensive in the first cost of distribution plant, cables alone costing £32

per KW. capacity. The regulation as to potential drop in rails puts direct supply out of court as soon as the distances and traffic exceed certain moderate figures. It seems, however, that a modification in track construction, using continuous girder supports under the rails and dispensing with concrete and setts between them, should be a logical consequence of electrical traction, and that the conductivity of the track might thus be largely increased and bonding made much more permanent without much increase in construction cost. The difficulty now experienced at the joints of tram rails should disappear, and the life of the road be greatly increased. For electric traction purposes the granite between the rails is entirely unnecessary. Municipal tramway engineers might give this a trial; companies cannot do so in the present state of the law.

The first alternative to this costly single-station system is the provision of a second generating station (Diagram C), still using low-tension plant distribution, and retaining T as one station, as the plan indicates that T is fairly well placed for the eastern part of the system. The junction I appears to be a good position, consequently the second station is assumed to be at that point. The arrangements east of T will remain unaltered. On the west, the two stations ought to supply power up to equidistant points measured along the tracks. The cross-country conductor T J will not be needed, and though useful for enabling one station to assist the other in case of breakdown (a valuable advantage of multiplicity of stations), it will not be further considered here.

The equidistant point on the route T D C I is ·1 mile west of D, and on the route T D J I it is 1·68 miles south of D. The western station I will then supply all the cars between C and D and two out of the five between D and J; its load will then be 24 cars or 360 amperes, leaving T to provide for 33 cars or 495 amperes. The cost of generating and the most economical current density are taken at the same figures as for the single station.

T has to supply westward the current for 14 cars, or 210 amperes as follows:—

60 amperes for branch E M,		average distance	1 35	miles.
105 "	" T D,	"	1 17	"
45 "	" D J,	"	3 20	"

The two cars on branch F D are taken as before, as supplied *vid* F.

At the voltage drop of 15·8 per mile the total watts lost come to 5,500. East of T they are as before, 8,250 unboosted, 720 boosted. I has to supply 360 amperes as follows:—

30 amperes to branch D J,		average distance	3 3	miles.
45 "	" I J,	"	1·4	"
30 "	" J K,	"	3 9	"
15 "	" J L,	"	3 8	"
90 "	" C D,	"	1·6	"
30 "	" C F,	"	·8	"
30 "	" I C B,	"	1·35	"
45 "	" I B C,	"	·7	"
45 "	" A B,	"	2 1	"

The total watts lost come to 10,602. No provision is made in this for boosting, as only a little current is carried beyond the 50-volt drop limit, and under the circumstances that drop is unlikely to be exceeded in actual work.

The copper sections, weights, and values needed will be as follows:—

DIRECT FEEDERS.

Line.	Length, miles.	Amperes, mean.	Section Cu. sq. in.	Tons, Cu.	Value.
T F	9	157·5	·531	4·35	£655
F G	1 25	120	·342	3 56	538
T E	·35	203	·579	1 84	278
E D	2 00	98	·277	5 02	758
I B	1 1	75	·213	2·13	323
I C	·9	142	·404	3 30	498
I J	2 8	98	·277	7 01	1,058
C D	1 65	45	·129	1 93	292
	10 95			29 14	£4,400

BOOSTED.

T O ...	$\frac{3\,8}{14\,75}$	...	45	...	·134	...	4·63	... £699

Total 33 77 tons, value £5,099.

The cost of distribution on the trolley side is thus:—

Loss in direct feeders, 24·37 KW., worth annually ...	£411
Loss in boosted feeders, ·72 KW., worth annually ...	16
Annual charge on boosters	6
Interest on direct feeders, 7 per cent. £4,400 ...	308
Interest on boosted feeders, 7 per cent. £699 ...	49
Total	£796

This works out per unit delivered to the cars $\frac{£796}{2,340,000}$ = 0·81d., or total ·831d., disregarding losses in returns.

The track feeder east of T remains, as before, and that west of T must tap the rails at D and carry 120 amperes, have a section of ·391 square inch with a drop of 35·5 volts, needing a booster of 4,260 watts. From I one feeder to J carrying 43 amperes section ·140 square inch, drop 42·2 volts, will require a booster for 2,600 watts. No other will be needed, though a small addition to the service and load on the line between A and D would call for a feeder to B or C. The track feeders are then as follows:—

Line.	Miles.	Amps.	Section sq. in.	Tons Cu.	Value.	Drop.	Loss watts.
T E'ward	2 97	120	·39	10·5	£1,585	41·6	5,000
T W'ward	2 35	120	·39	8 33	1,258	35 5	4,260
I S E ...	2·8	43	·14	3·55	536	42 2	1,815
	8 12			22 33	£3,379		11,075

Boosters to a capacity of, say, 18 KW. will be needed, costing £270. The cost of distribution on track side will thus be:—

Loss in feeders, 11 075 KW., worth annually ...		£252
Interest on cables, 7 per cent. on £3,379 ...		236
Charges on boosters, 15 per cent. on £270 ...		41
		£529

and the total cost of distribution:—

Trolley side	£796
Track side	529
	£1,325

equal to ·135d. per unit, or a total of 885d. The capital cost of the cables will be £8,478, their length 22 87 miles, laid in 13 85 miles of trenching, and the cost of boosters £310.

The cost of the cables amount to £18 per KW. full load output, and the efficiency about

$$\frac{427\,5}{468} = 91·5 \text{ per cent.}$$

The annual costs of generation and distribution as above qualified will be £8,751, or £1,185 less than with the single station, and this sum is the margin out of which the extra working and capital charges due to the use of a second station have to be met. Unless such extra charges exceed the saving in distribution, the two-station system will be the more economical. A sound knowledge of the local conditions should enable a fair estimate to be made, but it is not susceptible of calculation on general principles. The incidental advantages of the multiple-station system should be carefully considered in each case, and if the calculable operating costs are about equal, those advantages should turn the scale in its favour.

(To be continued.)

THE INSTITUTION OF JUNIOR ENGINEERS.

AT a meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel on Friday, May 18th, the vice-chairman, Mr. E. A. Berry presiding, a paper was read by Mr. Charles H. E. Rush and Mr. Basil H. Joy, entitled "A Short Review of the Motor Car Industry, Past and Present." The authors pointed out that the shortness of time at their disposal for the reading of a paper obliged them to confine themselves to a description of oil-driven vehicles only, other systems being only briefly alluded to.

The enormous advantages to be gained by using motor instead of horse-drawn vehicles were summarised as follows:—(1) Economy in working; (2) Increased possibilities in speed; (3) Greater safety; (4) Infinitely greater radius of action; (5) Humanity; (6) Economy in road repairs; (7) Cleanliness in streets; (8) Increased volume of trade; (9) Fewer unemployed. It was shown how restrictive legislation had hampered progress in the industry under consideration giving our Continental rivals a great lead over us. In comparing the merits of the various motive powers which can be employed, compressed air and gas were not considered, but steam was shown to have many advantages which, for heavy haulage, made it supreme; electricity, except for very limited purposes, was regarded as impracticable at the present time; while oil, or rather petroleum spirit, in spite of its many disadvantages, was shown to be the motive power for light tradesmen's vans and all light vehicles where long distances were to be covered.

The action and construction of the Daimler motor were then described in great detail, together with its application to a motor vehicle, illustrated by diagrams and an excellent full size section model of a motor and gear box lent by the Daimler Company. The method of governing was referred to, and its complications pointed out; a new and very simple form was illustrated, in which the working parts are reduced to one, and it was stated that it had given great satisfaction on a car which had run some 300 miles.

The De Dion and Benz motors were then described, and the complicated reversing arrangement of the latter fully treated. The question of ignition was next dealt with, and the three methods, tube, electric, and magneto-electric being fully described, preference was given to the first named, as giving on the whole the least trouble. The various methods which can be employed for transmitting the power from the motor to the countershaft, and the different devices by which is overcome the difficulty of obtaining variations of speed in a motor vehicle, fitted with a motor in which the speed is not variable, were described.

It was shown that the question of steering was not quite such an easy matter as might appear at first sight, but difficulties had been overcome by the Ackermann, and again by the more geometrically perfect Davies gears; other forms were briefly referred to, together with various methods of reversing.

Spray and surface carburretters were then described and compared

preference being shown for the former, as requiring less adjustment of the mixture when running. The importance of an efficient method of keeping the cylinder heads cool was touched upon, and the Cannstatt-Daimler cooler, which it was mentioned was very much on the lines of a marine condenser, was described as being about the most efficient now on the market, the evaporation being practically *nil*; its weight and cost, however, were great. It was noted that air cooling is successfully adopted for small powered motors up to 2½—3 H.P.

The disadvantages, amounting almost to dangers, of the ordinary band-brake were referred to, and illustrated by experiences on the recent 1,000-mile trial, in which they failed to hold vehicles from running backward down hill, and it was suggested that the expansion or internal band-brake would meet this objection. The desirability of pneumatic tyres for motor vehicles was urged, and a brief reference made to the various forms of wheels used on such vehicles.

The authors concluded by stating that they had only been able to touch upon a few of the better known forms of vehicles now on the market, but that there were many others which might be considered equally as good, though not so well known.

By way of an appendix, some quotations were made from a paper read by Prof. H. S. Hele-Shaw, Hon. M.Inst.J.E., before the Institution of Mechanical Engineers, on the same subject, and the conclusions to be drawn from the recent 1,000-mile trial organised by the Automobile Club were tabulated, showing that the English 6 H.P. Daimler cars are fully equal to the French 6-H.P. Panhard cars; that the French pneumatic tyres are better than the English; that even small 3-H.P. voiturettes can be depended upon to do such long distances as 1,000 miles; that the dangers prophesied for running a large number of vehicles at high speeds on the public roads have proved to be non-existent, owing to the wonderful control under which they are at all times; that the 12 miles an hour legal limit is unnecessarily low; it is not adhered to, and no evil results have accrued.

An animated discussion ensued, in which Messrs. P. Marshall, Loftus Perkins, A. Tingle, G. C. Allingham, L. F. Awde, S. Boulding, A. C. Kent, G. Gentry, A. K. Smith, E. Shrapnell-Smith, W. J. Tennant, and E. A. Berry took part, and the meeting closed with a special announcement of the Summer Meeting of the Institution to Newcastle-on-Tyne, August 11th to 18th.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

Seth Thomas asks: "Are the owners of a vessel liable for damage done to submarine cables by a dragging anchor, when the vessel is within the three mile limit?"

*** It was decided in 1854 that the alien owners of a ship sailing upon the high seas beyond the three mile limit from shore, from which an anchor was dropped, and injured a telegraph cable, were liable to the owners of the cable for negligence and the consequent injury (Submarine Telegraph Company *v.* Dickson, 1864, 15 C. B. N. S. 753). It seems that the Court will presume that the masters of ships are aware of the existence and situation of submarine cables, and that a duty was thereby cast upon all such masters of ships so as to manage their vessels so carefully and skilfully as to avoid (if possible in the exercise of reasonable precaution) injuring these cables.

The right of action does not appear to be confined to the three mile limit. In 1870 the Admiralty Court held that it had jurisdiction to entertain any action instituted by the owners of a telegraph cable against a ship whose crew damaged the cable in the attempt to free an anchor entangled therewith, and thereby caused injury which, by the exercise of proper nautical skill, might have been avoided. The *Clara Killam* (1870 L. R. 3 Ad. and Ec. 161)

TEST WITH SUPERHEATED STEAM.

A paper has been presented to the American Society of Mechanical Engineers concerning a small pumping engine by Simpsons, of London, at the St. Albans Water Works. The engine is a duplex direct-acting triple expansion, with six cylinders arranged in two tandems. Steam jackets are on the cylinder sides only, with boiler pressure steam. The cylinders are respectively 12 inches, 18 inches, and 29 inches by 18 inches stroke; the water plungers being 14 inches diameter, and the surface condenser is in the course of the main delivery.

The superheaters are of the Schwoerer type placed in the downtake of the Lancashire boilers, and they expose 60 square feet in each boiler. The pumps draw from closed tubular wells bored into the chalk, which here rises to the surface. The amount of water pumped was evidently about 1,400 gallons per minute, and presumably the total head was measured by a pressure gauge, as the water level in the wells could not be measured, these being connected directly to the suction pipes. We know, however, that these wells yield most copiously.

As every one of the five tests were practically under equal conditions as to load the results are fairly comparative, and show about 93 per cent. mechanical efficiency, and the conclusions drawn from the results are that with about 125° of superheat, the economy is about 16 per cent., the steam pressure being about 87 lbs. per square inch.

Nearly 30° more were added in the superheater and lost before the engine was reached, this loss, by the way, appearing to offer a ready solution of the problem of finding the heat losses from steam pipes—a far easier way than measuring the condensation.

The foot-pounds of duty per B.T.U. were found to be 94·20 with superheated steam in cylinders and jackets, 89·12 with superheat, but the jackets open to atmosphere, 89·56 with superheated steam in cylinders and jackets, but with a 1½ inch pipe open between the two intermediate exhausts, 84·53 with saturated steam throughout, and 82·06 the same, but with the cross exhaust pipe open.

Steam jacketing throughout only saved 4 per cent. of the fuel. The cross exhaust pipe helps the engine, but costs 5 per cent. of steam. Allowing 2 per cent. for slip and leakage, the engine will perform 96,000,000 foot-pounds per million B.T. units, an effective horse-power for 18·3 lbs. of steam per hour. These are good results for so simple a form of engine.

THE COST OF LIGHTING BY PRIVATE INSTALLATIONS v. PUBLIC SUPPLY COMPANIES.

In a recent issue of our contemporary, the *Engineer*, this subject was dealt with in an interesting article in which a table was given of the relative cost of the electric light for an installation of 50 and of 100 16-C.P. 60-watt lamps when the current is obtained from the supply mains at prices varying from 2d. to 7d. per Board of Trade unit, and the cost when obtained by a generating plant, the prime source of energy being steam, gas, oil and water, with and without storage.

The conditions assumed are, that the plant is supposed to run 1,800 hours per year, and for simplicity the whole of the lamps are taken to be alight for this period. Coal is put at 20*s.* per ton, including cartage, and the consumption of fuel is assumed as 5 lbs. of coal per B.H.P.-hour in the smaller plant and 4½ lbs. in the larger. The consumption of gas is taken to be 22 cubic feet per B.H.P.-hour for the smaller plant and 20 cubic feet for the larger. The oil engines are allowed 1¼ lbs. of oil at 6d. per gallon per B.H.P.-hour. The engines are of 5 and 10 H.P. respectively, and are assumed to have a mechanical efficiency of 80 per cent. Nothing is said as to the efficiency of the turbine, but apparently the cost of water is taken to be equivalent to the interest upon the outlay in making the water-ways and tail-race, which is assumed as equivalent to the cost of the turbine itself.

The accumulators are of sufficient capacity to keep 50 lamps alight for a period of three to four hours, and the cost of oil, waste and stores is put at ½d. per unit generated.

From the conditions of running above stated, it would appear that the units generated must be equal to

$$\frac{50 \text{ lamps} \times 60 \text{ watts} \times 1{,}800 \text{ hours}}{1{,}000}$$

= 5,400 units in the case of the plants which are running without accumulators. In the case where storage is provided, the units generated for a given lamp output must, of course, be higher. The amount of energy generated over and above lamp requirements will depend upon the extent to which the accumulator is used as a pure storage of energy, or as an equaliser, and also upon the amount of "gassing" which the intelligent labourer (to be referred to later) may think requisite and necessary for the good of the accumulator. The extra power generated would, however, be 20 per cent. at a moderate computation, but no allowance has been made for this in the cost of fuel, the same figure having been inserted in the table in each case.

The cost of oil, waste, and stores is fixed at rather a low rate. It would, in all probability, exceed 3*s.* per week in the case of these small installations, as the character of the attendance allowed for is not such as to ensure a high degree of economy. It is stated that in the calculation of charges for attendance it has been assumed "that an intelligent labourer at 25*s.* per week would be quite capable of attending to a

small steam plant, while a smart lad at 15s. would soon learn to look after an installation using a gas or oil engine. . . . . For attending to the accumulators an extra shilling or two in wages per week has been allowed."

Much is heard of the "intelligent labourer" who looks after an electric lighting plant to the complete satisfaction of those who advocate private installations instead of the use of the public supply main, but we must confess to a feeling of scepticism as to the general existence of latent engineering talent among labourers, intelligent or otherwise, particularly in towns.

It is unreasonable to expect any machinery to do work economically without a certain amount of skilled supervision, and this the "intelligent labourer" is not competent to give. As long as the machinery is new and things are going right, no difficulty is experienced, but the intelligence of the labourer cannot be expected to be equal to recognising signs of incipient trouble, and when a breakdown occurs, the intelligence usually vanishes. Recently we happened upon an installation in the country which had been for three days under the charge of the "intelligent labourer." He admitted that he knew nothing about it, but said he had done as he was told. He had been told to shift the brushes about if there was sparking until a non-sparking position was reached, but he either had not been told that the brushes should lie at opposite ends of a diameter, or he had forgotten it. He appeared to have spent the greater part of his time in shifting the brushes (one of which the writer found had a lead of three sections compared to the other) without discovering the coveted position. The state of that commutator may be imagined. Such repairs as these are, of course, not taken into account in the table given in the article in question.

The allowance for depreciation of accumulators which are left in charge of the intelligent labourer is certainly too small when put at 10 per cent. It is doubtful whether any manufacturer would care to undertake their maintenance in these circumstances at anything approaching this figure.

The figures in the tables are no doubt arithmetically correct, but the conclusions drawn from them by the writer of the article are not necessarily so. For instance, although the figures may show clearly enough that electric energy can be generated even for so small a number of 16 C.P. lamps as 50—on the 90,000 lamp-hour per annum basis—at a less cost than 7d. per Board of Trade unit, we do not think that any consulting engineer who has a conscience would recommend a client to put in a private electric generating plant for 50 lamps when the public supply company's main passes his door; nor can we think that even if the aforesaid client fell into the hands of one of those electrical advisers who see "a field for the profitable introduction of electric plant" in every instance, it would be easy to persuade any client possessing even a modicum of common sense to have engines, and dynamos, and accumulators, with an intelligent labourer thrown in, when he can get his current straight from the supply main.

The conclusions in our contemporary's article refer to 50 and 100-lamp installations, as if the figures in the table might be taken, in practice, to apply to such installations, but this is misleading in that the assumptions upon which the figures are calculated are avowedly that all the lamps burn 1,800 hours per annum. Such a condition of things is altogether exceptional, in fact, we doubt if a single instance could be found of a private installation working under these conditions. The experience gained in every-day work extending over years points to 13 or 14 units per 8 C.P. lamp installed as a fair representative consumption per annum, whereas in the examples discussed in the article the yearly consumption per 8-candle lamp would be 54 and 108 units respectively. On the basis of actual experience then, the table should refer to installations of 200 and 400 lamps.

We are quite sure that this point has inadvertently been left out of consideration by our contemporary, who, with laudable anxiety to formulate a simple basis of comparison, has forgotten the erroneous conclusion to which a comparison of the figures arrived at might lead.

In the case of installations of 50 and 100 lamps, where in general the number of burning hours would be found to be one-quarter of the number assumed, the first cost of plant and erection, annual cost of attendance, and interest and depreciation would be the same, while the only item that would be diminished to any extent would be the cost of fuel, and only in the case of the oil and gas engine would this be in any way proportional to the reduction in the output. Turbines may be left out of account in the comparison, at least, in England. If, then, the table is to apply to installations of 50 and 100 60-watt lamps, the figures in the column relating to the total annual cost of production from generating plants should be decreased by a proportionate amount for saving in fuel and oil, waste and stores, whereas the annual cost of current from the supply mains would be exactly proportional to the reduction in the quantity used (on the system of charge assumed in the article).

In the following table the comparative figures arrived at by the *Engineer* and the figures as corrected for practical work are placed in parallel columns :—

COMPARATIVE ANNUAL COST OF CURRENT FOR INSTALLATION OF 50 AND 100 60-WATT LAMPS.

—	The *Engineer's* figures, assuming consumption of 54 units per 8-C.P. lamp installed.		Corrected for usual burning hours at 14 units per equivalent of 8-C.P. lamp installed.	
	50 lamps.	100 lamps.	50 lamps.	100 lamps.
Steam ...	£117 5 0	£149 15 0	£104 5 0	£124 15 0
Gas ...	95 9 9	128 5 0	74 9 9	90 5 0
Oil	97 11 0	144 11 0	75 11 0	97 11 0
Electric supply, allowing £1 and £1 5s. respectively for meter rent.				
at 2d. per unit	£46 0 0	£91 5 0	£12 5 0	£23 15 0
„ 3d. „	67 10 0	136 5 0	17 17 6	35 0 0
„ 4d. „	91 0 0	181 5 0	23 10 0	46 5 0
„ 6d. „	136 0 0	271 5 0	35 15 0	70 15 0

The figures, as altered to suit the conditions under which a 50-lamp installation would work in practice, need no comment.

While we admire the pains taken in working out the figures contained in the table above referred to, and while on broad principles we admit that for a 10-H.P. plant steam is dearer than gas, and that water-power is cheaper than either, we are not prepared to admit any of the conclusions arrived at as accurately representing the results which can be expected from a 50 and 100-lamp installation respectively, nor can we endorse the statement that "a gas engine can be fixed in a corner of a cellar," that is to say, we do not deny the physical possibility of such a feat, provided the corner were given three dimensions, but we do not think such a proceeding conducive to economy.

No mention is made of the distance allowed between the water-power and the house lighted. Water-powers generally have an inconvenient habit of being located in some isolated place a long way from the spot to be lighted, and in most cases the cost of transmission would be a considerable item at the practicable E.M.F. for house lighting. If the water-power could be fixed in the corner of a cellar it would, of course, simplify matters.

MR. R. A. FESSENDEN ON THE DIMENSIONS OF μ AND k.

IN a well-known paper read before the Physical Society in 1892, Mr. W. Williams worked out a method of testing the reasonable probabilities of different theories of the ether by considering the dimensions of the several electrical quantities. He reached the general conclusion that, of all possible systems, "only two give rise to dimensions whose interpretations are intelligible, natural, and connected as a whole; which interpretations accord with the two rotational theories of electro-magnetism which have been hitherto put forward." He did not propose any means of deciding between the two. The paper contained a closely reasoned statement of the view of dimensional formulæ that they represent the real nature of the quantities, so far as they depend upon mass, space and time, and not merely numerical relations between the units; and also introduced systematically the representation

of vectors in different directions as being different physical quantities. This paper produced a distinct advance in the accepted views of the nature of physical dimensions, though in books published since 1892 the dimensional formulæ of the electric and magnetic units have not generally been written in the forms given by Mr. Williams.

In a long paper printed in the January and February numbers of the *Physical Review* (America), Mr. R. A. Fessenden gives some further reasons supporting Mr. Williams' main conclusions, and proposes a mode of discriminating between the two possible systems of units, and the two corresponding theories of the ether, which were left by the sifting process. To effect this discrimination is an object of great interest and importance, and Mr. Fessenden's work demands close attention.

In one of the two systems of units to which both these writers reduce the possible area of choice specific inductive capacity, or k, has the dimensions of mass per unit volume, or density; and ν the reluctivity, the inverse of μ the permeability, has the dimensions of energy per unit volume. In the other system μ has the dimensions of density, while k has the inverse dimensions of energy per unit volume.

Tabulating these with the dimensions of F and H, the electric and magnetic forces respectively, we have :—

System 1.	System 2.
$k = M X^{-1} Y^{-1} Z^{1}$	$k = M^{-1} X^{-1} Y Z T^{2}$
$\mu = \nu^{-1}$	$\mu = \nu^{-1}$
$= M^{-1} X Y^{-1} Z T^{2}$	$= M X^{-1} Y^{-1} Z^{-1}$
$F = X T^{-1}$	$F = M X^{-1} T^{-2}$
$H = M Y^{-1} T^{-2}$	$H = Y T^{-1}$

X being a vector in the direction of the electric displacement, Y of the magnetic displacement.

Mr. Fessenden following the practice of all the older writers ignores the distinction between X, Y, and Z (although in another part of his essay it is clearly recognised), and writes the dimensions as follows :—

System 1.	System 2.
$k = M L^{-3}$	$k = M^{-1} L T^{2}$
$\mu = M^{-1} L T^{2}$	$\mu = M L^{-3}$
$F = L T^{-1}$	$F = M L^{-1} T^{-2}$
$H = M L^{-1} T^{-2}$	$H = L T^{-1}$.

It is then observed that in one system the dimensions of H are inverse to those of μ, and in the other the dimensions of F are inverse to those of k, so that in one of the two possible theories of the ether the electric force and the inverse of the specific inductive capacity are physical quantities of the same essential kind, while according to the other theory, the same observation holds of the magnetic permeability and the magnetic force. If, then, Mr. Fessenden argues, it can be shown that one of these relations holds and not the other, one theory will be established and the other displaced; and if it can be shown that in any and every substance the inductive capacity is inversely proportional to the electric force, the second system would be supported; while if, on the other hand, it can be shown that in every substance the permeability is inversely proportional to the magnetic force, the first system would hold.

To quote his words :—"*Of k and μ, the one which is a compliancy will be an inverse function of the corresponding force.* This is our touchstone, this relation. We know at once that the capacity of a condenser does not decrease when we increase the voltage on it, whilst we know that the permeance of a magnetic circuit does decrease when we increase the gilbertance. It remains to be proven that the rate of this change is that called for by the equation."

That the specific inductive capacity is not proportional to the force is obvious. In fact, in most substances it does not vary with the force at all. Prof. Fessenden decides accordingly definitely against the second system, viz., when μ is a density, and proceeds to examine the case for the first system, viz., the relation between μ and H. The result of careful experiments on soft iron was to establish the truth of Kennelly's formula over a large range (H = 2 to H = 83), giving the equation $(\mu - 1)^{-1} = a + b\,H$. The quantity $\mu - 1$ is considered for iron to be real quantity contemplated in the definition of permeability, and the equation is written $\nu = a + b\,H$, where ν is the reluctivity. Similar relations between the permeability and the force were obtained from the results of other experimenters on steel, iron filings, iron amalgam, and a solution of ferric chloride.

The establishment of a linear relation between ν and H for several very different materials is regarded as a satisfactory confirmation of the hypothesis that the dimensions of the two quantities are the same. This being so, the dimensions of b and of B are those of pure number.

The argument is neither very clear nor very satisfactory. It is true, of course, that if observations of ν and H are observations in different ways of one and the same effect, then the measure obtained of ν should under all circumstances bear a definite numerical ratio to the measure obtained of H, and instrumental conditions might exhibit the linear relation between the two in the particular form obtained by Mr. Fessenden. But if ν and H (even if they have the same physical dimensions) are not measures of one and the same thing, no linear relation will generally hold between them; and on the other hand, if a linear relation is found to hold between two quantities, it does not follow that they have the same physical dimensions. As a simple example, consider Watt's parallel motion. The angular movements of the two pivoted arms are quantities of the same kind and have the same dimensions, but they are not connected by any linear relation. On the other hand the area swept out by the motion of one of these arms is proportional to the angle through which it moves, so that the said area and angle are connected by a linear relation, although they are of different dimensions.

A reference to the mode in which the dimensions of other quantities have been ascertained shows that Mr. Fessenden's line of argument is very different from any previously followed. To heat and kinetic energy are assigned the same dimensions, simply because one can be turned into the other. The quantities $Q^2 K^{-1}$ and $P^2 \mu^{-1}$, where Q and P are electric charge and magnetic pole respectively, are assigned dimensions $M L^3 T^{-2}$ simply because forces due to those quantities produce effects on matter exactly similar to mechanical forces.

While the mode of argument appears unsound, it seems that if it could be defended it would defeat its own object. It is intended to show that μ^{-1} and H have the same dimensions. But if they have the same dimensions, B has the quality of a pure number, while on the hypothesis that k has the dimensions of density, B would have the dimensions $X Z Y^{-2}$. So that if the argument is sound, even the last possible theory of the ether left by the eliminating process fails.

So far as the present writer can see, the sort of considerations that Mr. Fessenden has employed do not assist us to decide between the two possible theories of the ether; but notwithstanding this his experiments on the relations of H and μ, the great quantity of information given under the head of corroborative evidence, and the ingenious proposal for rationalising the electrical equations make the paper one of exceptional value and interest. A debatable proposition is better calculated to make a paper interesting than one that is indisputable. Mr. Fessenden's proposals for rationalising the units have been discussed in a recent issue of this journal.

W. A. P.

THE PROTECTION OF INSULATED WIRES.

By FREDK. BATHURST.

Although I have followed up Mr. Sydney F. Walker's article which has just appeared in the Electrical Review, it seems to me that he leaves us in very much the same position as we were in before. He reviews and criticises the methods of wiring in commercial use, but when many of his points are placed in comparison with one another, they are difficult to reconcile, and he does not seem willing to express his opinion positively.

Amongst the good points on which he is positive and clear, and which are "things to be remembered," he points out that whilst the erection of wiring *may be* in the hands of

able trained men (or as likely *not* to be), the customer for whom the work is done does not usually claim any electrical knowledge whatever, and his main wish is to have the work done as cheaply as possible, even if in time he may find himself "done" also.

Escaping the question of workmanship, and dealing more with permanence, Mr. Walker points out that the danger lies in the provision of wires whose insulation will deteriorate after a number of years, or which may be damaged either mechanically or chemically, and in placing these wires in such positions, or under such conditions, that serious trouble may arise when the insulation becomes weakened. The best protection is for the consumer to have his installation periodically tested, and arrange that the wires which ought to be renewed should be renewable with as little inconvenience as possible.

The "definite life" of ten years which Mr. Walker takes is open to question both from wire makers and consumers, the one claiming and the other demanding a much longer period; but practically the length of life depends upon the particular conditions encountered and the quality of the protecting medium which has been installed to meet the conditions anticipated.

Coming, then, to the fact that concealed wiring is an increasing necessity, the casing system is dealt with and its weakness pointed out, concealed work being more liable to trouble than surface work, and the conclusion is arrived at, that whilst it should be creosoted or shellacked, it is at its best but a poor makeshift.

Mr. Walker points out that experience already shows that vulcanised rubber-covered wires, either in casing or in plain —that is, *unlined*—pipe, have failed in the presence of damp, and also that when vulcanised rubber-covered wires are laid in thin steel tubes made from rolled-up strip with a longitudinal joint "more or less" open, such wires would be subject to nearly the same influences as wires laid directly in plaster. When such "conduits" are plastered over, they would form channels for distributing water which penetrated anywhere over the system; also that thin iron tubes, even when varnished or enamelled, quickly rust, becoming a network of "wire-ways," in name only, rather than a permanent system of protecting tubes. The life of a wiring system of this kind depends mainly upon the thickness of the rubber and the pipe.

Lead-covered wires are favourably touched upon, the main objection pointed out being the possibility of a puncture or a crack in the lead tube, causing early breakdown of the insulation.

He concludes with reference to lined metal pipes (particularly mentioning glass-lined pipes), and criticises such a system mainly on the score of its first cost.

I am in accord with the foregoing statements, but I think that Mr. Walker is somewhat off the lines when he states that the committee adjudicating for the Society of Arts upon the prize essay offered in connection with the solution of the wiring problem decided that iron pipes lined with *glass* formed the best suggestion.

The writer is under the impression that he (peace my rivals and competitors!) should have some information in this matter, and is unaware that a glass lining was specially commented upon, and would point out the physical impossibility of obtaining a glass of a sufficiently flexible nature that would allow the pipe to be handled and bent. It is true that attempts have been made in this direction, but the practical success they have met with has been very limited. To-day the writer is able to say that the general experience gained with insulating lined tubes (using a fibrous bituminised material as their basis) have given full and complete satisfaction in every condition of installation. It is true that under the present two-wire principle of installation their cost can be criticised in comparison with the "cheap" competitors which their success has created. Such competitors prefer to blink the gas, water, and other "tight" requirements, suggested by a high authority as qualities theoretically necessary; but experience is undoubtedly proving that the more closely the conduit is able to offer all these qualities, the more admittedly perfect it proves in practice. Although these competitors admit the necessity of efficient mechanical protection for the enclosed wires, they seek to find inexpense in first cost of material and installation by adopting a thickness of material which a few years' practical use will show is quite insufficient. Further, whilst laying stress upon the necessity of securing a smooth and even interior surface of conduit, the desideratum of "cheapness" has overweighed the consideration of good mechanical construction, and the construction adopted can readily produce the very difficulties sought to be avoided. The specious suggestions that no joiners are required, and that the simplicity with which the junctions and connections are accomplished, has done away with all "screwing and fitting," does not form a good argument for the conclusion that *consequently* there can be no abrasion of the wires. "Fitting" necessarily means that a certain amount of labour is intentionally provided to overcome this possibility of difficulty. Although sufficient "mechanical protection" is made the strong point by low-priced competitors, they themselves allow that the thickness of the metal should be such that the possibility of an accidental arc inside the conduit should not be able to burn out the pipe, but probably this point has to be admitted more from the view of the possibility which exists for direct competition with themselves by the production of a close-joint tube made from still thinner metal strip than they at present employ, and which it is open for any of the numerous Birmingham firms producing "close-joint bedstead tubes," to place on the market.

It is difficult to see the point of Mr. Walker's statement that "as the pipe is only required to protect the wire from other things, and itself not to burn out in case the wire heats inside it, the longitudinal closing of the pipe is *unnecessary*," when he admits that used in concealed work these thin metal tubes quickly oxidise. Admitting that internal oxidation may arise from condensation, surely it is desirable to exclude the entrance of moisture from further external sources?

When dealing with the insulation on the wires, Mr. Walker states that he has "a very strong objection to placing any conducting material on the outside of the insulation, because of the danger that the insulator may be damaged in the process of putting on the outer conductor." It would appear then, that he might rather agree with the practice upheld by the advocates of insulating conduit, in which a strong and complete outer mechanical protection is provided, and under which the insulating material can be laid and installed without the same risk of being damaged.

As Mr. Walker has evidently not had enough experience with insulating lined pipes to become convinced as to the extra mechanical and electrical protection such material offers over its rivals, the writer would be willing to provide for him, free of charge, a sufficient quantity to enable him to make practical tests as to the extent to which the insulating lining is unpierceable by a "short-circuit" arc, and how it serves to keep any prematurely faulty conductor permanently insulated from the outer metal protective sheathing. His argument that everything will melt in the arc, is correct, providing the arc is steadily maintained in the same position upon it for a certain time, the tendency of an arc occurring inside the tube is, however, to travel along the wires rather than to maintain a fixed position, and in this way a fresh refractory and insulating surface is always presented towards it, but whatever may be the correct explanation, a practical test should prove the most convincing argument.

Mr. Walker will be aware that with the recent growth of bare pipe systems experience has already shown the possibility of one wire becoming connected to the pipe, and that the current can be thus diverted to neighbouring gas and water pipes, with, perhaps, serious results. He must have noted the recent proofs in Glasgow.

Summing up the whole subject generally, we are gradually becoming convinced that electric wiring must compete in its cost, life, and efficiency with gas-piping practice, and the teaching of my experience in wiring practice is, that the growth and development of the art will, in spite of the "low first cost" requirements, tend to favour the use of the highest quality material, and that the workmanship required will improve in like ratio. Or in other words, as Mr. Walker puts it, in the process of obtaining cheapness, we must not run the risk of having to condemn within a few years' time the low-cost wiring work being carried out, and lay ourselves open to the possibility that when the condemnation takes place the result would be a serious set-back to electrical supply.

CURRENT SPECIFICATIONS.

XII.—LEEDS ELECTRIC LIGHTING.

Summary.

Scope of Tender.—Two 630-KW. two-phase steam alternators and one separate surface condensing plant capable of dealing with 2,000 I.H.P. engines.

Type of Engines.—Vertical, triple, three-cylinder engines, enclosed type, to work either condensing or non-condensing.

Speed Specified.—Not to exceed 300 revolutions per minute.

Steam Pressure available.—125 lbs. square inch at engine stop valve but suitable for working with 180 lbs. square inch pressure.

Emergency Load.—1,100 B.H.P. for two hours when working condensing.

Normal Load.—1,000 B H P. at normal speed and 125 lbs. square inch pressure when working condensing.

Type of Alternator.—Stationary armature and revolving field magnets, both mounted on iron cores.

Position of Alternator.—To be placed end-on to the engine with independent bearings.

Output of Alternator.—At normal speed to develop 630 KW. at 2,100 volts as continuous load and 693 KW. for two hours at same voltage as emergency load.

Periodicity of Circuit.—50 ~ per second.

Temperature Rise.—Measured thermometrically, not to exceed 60° F. after 12 hours' continuous working at normal full load.

Range of Regulation.—Not to exceed 6 per cent. between no load and full load, with power factor 1·0 or 20 per cent. under similar conditions with power factor 0·8.

Voltage Variation.—The voltage variation between windings when one fully loaded and the other open-circuited must not exceed 3½ per cent.

Fly-wheel Effect.—Not to be less than 1½ foot-tons per E.H.P. at normal speed of plant.

Exciter.—To be shunt wound and directly coupled to alternator.

Condensing Plant.—Surface type, with not less than 3,000 square feet cooling surface, and steam-driven air and circulating pumps.

Specified Date of Completion.—*12 months* from date of order.

Penalty for late Completion.—*One-half per cent.* per week on contract sum for either steam alternators or condenser.

Stipulations as to Wages paid to Workmen.—Unsatisfactory, see below.

Stipulations as to Removal of Foreman or Workmen —Satisfactory.

Arbitration.—Unsatisfactory, see below.

Terms of Payment.—Satisfactory.

Date for Receipt of Tenders.—May 28th, 1900.

There are several interesting features in this specification, which has been prepared by Mr. H. Dickinson, A.M.I.C.E., M.I.E.E., the electrical engineer to the Corporation. It marks a departure from previous practice, for whereas the existing plant is wound to supply energy single-phase at 83 ~ per second, in future an attempt will be made to cultivate a mixed lighting and power load by means of two-phase 50 ~ current. Although Leeds is not the pioneer in this respect, the possibility of a large motor load will render the results of working of great value. There promises in the future to be as great rivalry between multiphase and direct currents for the supply of mixed lighting and power circuits, as in the past existed between the use of single-phase or direct currents for lighting purposes only.

There is little calling for special notice in the engine specification, several types would comply with the requirements, and as regards steam consumption, 26 lbs per KW.-hour at full load, when working condensing with presumably 125 lbs. square inch steam pressure is asked for, under a bonus or penalty of *£200* per 1 lb. of steam per KW.-hour.

Tenderers should, however, note that, contrary to usual practice, they will be called upon to pay all costs, including coal, water, and oil for the tests to be carried out on site after erection.

A stipulation to which exception should be taken gives the purchaser power, at contractor's risk, to put the plant into beneficial use from the time of erection to the date of granting the engineer's certificate.

It is specified that the alternator shall have revolving magnets and a stationary armature with iron cores to both, but we presume that any type of machine which complied with the regulation and paralleling requirements would prove acceptable. The temperature clause is slightly more stringent than usual, and the regulation requirements, especially under an induction load, are severe. We are glad to note that while nothing impossible is asked for, the standard of excellence required is such that to meet it machines fully equal to the high standard associated with British engineering work will be necessary.

There is internal evidence that the general conditions have not been written by the same hand as the specification. They are in many respects open to the same objections we are so often compelled to bring against Corporation specifications. For instance, the arbitration clause is limited. It states :—

> **In case any dispute or difference whatsoever shall at any time or times hereafter arise or exist between the contractor and the Corporation touching their respective rights or obligations under the said contract, or the fulfilment or non-fulfilment thereof or incident thereto, *other than such matters as are herein specifically directed to be referred to or decided by the engineer as mentioned*, such dispute or difference shall from time to time, at the instance or request of either party, be submitted to and decided by the arbitration of two arbitrators, one to be nominated by the contractor and the other by the Corporation, and the proceedings under and consequent upon the said last-mentioned reference shall be conducted, and any award or awards to be made thereunder shall be subject to and be governed, conducted, and affected by all the incidents, consequences, and effects of a reference to two arbitrators under the provisions of the Arbitration Act, 1899.**

When we come to carefully examine the rest of the general conditions we find that these reserved matters contain such essentials as :—

> **Should there be any doubt or obscurity as to the meaning of any portion of these general conditions or of the specification, the contractor must set forth the particulars thereof, and submit them to the engineer, in order that such doubt or obscurity may be removed before the signing of the contract.**
>
> ***If any question or difference* should afterwards arise *as to the meaning of any dimensions, clause, word, sentence, or otherwise*, in these general conditions, or in the specification, or on the plans, sections, or drawings referred to in or forming part of the contract, *the engineer shall determine it, and his decision shall be final.***

And referring to variations in the work ordered during the progress of the contract by the purchasers, we find that :—

> ***The difference of cost occasioned by any such alterations*, amendments, omissions, or variations, *shall be ascertained in accordance with the prices attached to the tender*, and be added to or deducted from the contract price; and *where the rates are not contained in the prices attached to the tender, the engineer shall determine the amount of such additions or deductions, and his decision shall be accepted by the contractor as final.***

We are glad to notice that in respect to the preparation of drawings by tenderers some consideration is shown, for in many specifications the amount of drawing labour involved in the preparation of a tender is out of all proportion to its value. The clause here reads :—

> **The tenderer must submit with his tender a general plan in outline of all the plant included in his tender, drawn to as large a scale as is convenient.**
>
> **Detailed plans are not required at this stage, but if the tenderer wishes to call special attention to any detail of construction, he is at liberty to submit a plan of same.**

This is the first time that in any of the specifications dealt with in this series we have had a complete set of so-called labour conditions. There have been clauses to which it has been our duty to call attention, but no specification we have examined has borne so clearly the mark of the so-called friend of labour. These are far from being ideal from the trade unionist point of view, and are not so extreme as some which have come under our notice. Since, however, they give power to the purchaser under certain conditions to determine the contract and recover damages by legal means, which power cannot be exercised in the case of foreign manufacturers, insistence upon these conditions ought to be held to disqualify foreign competitors, else British manufacturers are placed at a distinct disadvantage.

The clauses referred to read :—

> **The contractor shall at all times during the continuance of this contract abide by, perform, observe, fulfil, and keep all and singular the stipulations following, that is to say :—**

(*a*) The contractor shall pay every workman employed by him, whether in or about the execution of this contract or otherwise, wages, and wages for overtime respectively, at a rate not less than that recognised in the district where the work or any part of it may be done, as the standard rate of wages in such workman's trade.

(*b*) The contractor shall observe and cause to be observed by each workman hours of labour not greater than the hours of labour—and also the conditions of labour—(other than any condition that union men only shall be employed), usually observed in the trade of such workman in such district.

(*c*) The foregoing conditions shall not apply to any trade or trades during the existence of a general lock-out in such trade or trades. *The Corporation shall be the sole judges as to whether such a general lock-out exists.*

(*d*) The contractor shall not transfer, assign, or under-let, directly or indirectly, this contract, or any part, share, or interest therein, without the written consent of the Corporation, under the hand of the town clerk, which consent may either be withheld or given subject to such terms and conditions as the Corporation may determine, and particularly that the person to whom such contract, or any part, share, or interest therein may be transferred, assigned, or under-let, shall abide by, perform, observe, fulfil, and keep the stipulations on the part of the contractor herein contained.

(*e*) *The contractor shall to the satisfaction of the Council, provide and keep proper books, in which shall be correctly and promptly entered from time to time the names of, the wages paid to, and the hours of labour observed by, all workmen employed by him, whether in or about the execution of this contract or otherwise,* and shall from time to time, when required by notice in writing under the hand of the town clerk, produce the same or any of them to him or the deputy town clerk, who shall be at liberty to inspect and take copies of or extracts therefrom.

(*f*) The contractor will, whenever required so to do by notice in writing under the hand of the town clerk, or deputy town clerk, attend himself and procure the attendance of anyone employed by him before the Council or any committee thereof, to give such explanations and information with regard to the observance or non-observance of the stipulations herein contained as may be required of him or them, but it shall not be necessary for such Council or committee to require such attendance, explanations, or information before determining this contract if they decide to do so in the manner hereinafter mentioned.

(*g*) *In case of any breach by the contractor or by any person to whom this contract or any part thereof or interest therein may be transferred, assigned, or underlet,* of any one or more of the stipulations in this clause contained, it shall be lawful for the Council to determine this contract in the same manner and to the same extent as they have power to determine the same under Clause 21 in the events therein specified; and if this contract shall be determined under this present power, then all the provisions of that clause shall apply as if the contract had been determined under that clause.

We feel sure that the time is fast coming when it will be necessary for tenderers to combine and refuse to assent to such arbitrary conditions as these. If the above were rigidly enforced, there is hardly a manufacturer in this or any other country who would not be at the mercy of the Council, for whatever may be one's own attitude towards their employés, it is a practical impossibility to pass on such responsibility as the above to every manufacturer with whom one may have business relations. We know that it is often stated that clauses such as the above are not enforced, and that they were never intended to be operative, but if so, they should not be inserted in the contract. *It is a grave injustice to the honest tenderer,* who makes a fair allowance for the risks in his tenders, and is thus placed at a disadvantage against a competitor who trades on the probability of the non-enforcements of the penalties. The only way to end the present somewhat anomalous condition of things in regard to this class of risk is for combined action on the part of *all* tenderers, and until this is done, no improvement or alteration is likely to take place.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held at the Institution of Mechanical Engineers on the 17th inst., the President, Prof. S. P. Thompson, announced that the final stage had been reached in the absorption of the Northern Society of Electrical Engineers into the parent Institution, and the secretary read a list of 66 names of additional members of the Institution provided by transfers from the now defunct Society. Prof. Thompson read a letter from Prof. Mascart relating to the Electrical Congress to be held in Paris, and desired those of the members who intended to prepare "reports" upon the special subjects in which they were interested, or had special knowledge, to submit them as early as possible to the Special Committee of the Institution appointed to deal with the Paris Congress, which will meet in August next.

Mr. A. C. Eborall then read his paper on "Alternating Current Induction Motors." The paper itself is dealt with in another column. The discussion was opened by Mr. M. B. Field, who thought an apology for the paper quite uncalled for, as it was very valuable, and although many of the devices described were not new, they would probably be new to many of the members, while the paper contained a collection of information useful to manufacturers and users. The method of stator winding described by the author was interesting, but depended upon friction to hold the plates in position. The question of tooling was very important in connection with stators, but not so much so for rotors. The figures given in the "Notes on Performance and Design" were also very interesting, and he suggested that figures relating to continuous current motors should be added. He pointed out that the losses in a rotor were doubled in a single-phase field as compared with a three-phase field. The starting of the Heyland motor was a radical departure. With the aid of the blackboard Mr. Field showed that the starting torque was proportional to the product of two fluxes, and explained the advantage of getting a very large starting flux, for given the formula $a\ b \cos \phi$, if $b = 2a$ the same starting effect was obtained as in a two-phase motor. In common with other speakers who followed him, he thought the paper was not quite clear in describing how Mr. Heyland provided the "certain winding arrangements" for altering the number of poles, and again using the blackboard, he dealt at some length with the action of the windings, depending upon whether the number of coils equalled the number of poles or the number of coils equalled pairs of poles.

Mr. Langdon Davies wanted a reason for the statement in the paper that single-phase motors which start up light should have slip rings after 7½ H.P. The question of producing a rotary field at starting in the Heyland motor again cropped up; details of starting without any resistance in the rotors being asked for.

Mr. Rhodes followed with the remark that although the subject had not for some time been brought before the members of the Institution, it was one which would have to engage the attention of engineers. He criticised the use made in the paper of the term "self-induction." In the case of a stationary transformer, the self-induction of a coil might be taken to be the number of lines of force in that coil; in the motor the running coil had a minimum leakage, while the starting coil was bound to have a large leakage. He rather preferred to look at alternating current motors from a physical point of view. The flux densities in iron given in the paper seemed to be too high. It was not customary to go up to 10,000 or even 5,000, owing to the large loss, and, after all, an induction motor is only a transformer, so the induction density should be kept moderately low. The bugbear of manufacturers was the absence of a standard frequency and pressure. It seemed that too much attention had been devoted to the stator windings, and for further improvement one would have to look to the rotor. The Heyland motor was, as far as the rotor was concerned, worked by the resistance idea of cutting down starting current, but putting in resistance into rotor coils only diminishes the demagnetising field, that is, cuts down the whole current, and the energy current, *i.e.*, that in phase with the E.M.F. induced in the rotor coils, was also affected. What was wanted, if possible, was to wipe out the self-induction of the rotor coils. It was impossible to do this by inserting non-inductive resistance; he had attempted the experiment of introducing into the rotor circuit a counter E.M.F.

Prof. Ernest Wilson exhibited a diagram showing the curves of weight plotted against mass-factor for alternating and continuous current motors. Prof. Carus-Wilson thought the most interesting part of the paper dealt with starting devices, and particularly the Heyland motor. In a single-phase induction motor what was wanted was a field at right angles to the primary, and a good lag with respect to the primary. The great disadvantage of a choker was that you wasted the field while getting a good lag. Mr. Heyland seemed to have taken some of the useful flux and allowed it to leak, thereby getting a leaking field out of step. He

found apparently it paid to take part of the field of the starting coil, making it leak and thereby getting the lag. In the comparison between single-phase and multiphase it has to be remembered in connection with speed regulation that the most convenient way is quite useless with single-phase. In a single-phase motor one gets all the objectionable effects of a multiphaser just doubled. Most of the attention of alternating current engineers was devoted to increasing the power factor. Prof. Wilson then referred to Mr. Steinmetz's "remarkable results" obtained by using a condenser with a single-phase motor. If the starting coil was taken and connected to a condenser, quite surprising results were obtained, but the matter had not yet been made quite clear. By properly choosing the capacity, the condenser supplied the cross-current, and by this means the power factor had been raised to 100. It was perfectly true that no starting advantage was obtained, but a single-phaser had been run with a power factor of over 97 per cent., and as good as a polyphaser.

Mr. Ferranti put it that the sting of the paper was in the "conclusion," that single-phase supply was played out. If so, it was a great pity to take up the time of the meeting with the paper, but he thought that single-phase systems were just commencing their phase of usefulness, "provided you do it the right way." He prophesied that in less than a year engineers will be planning a single-phase power supply which would be found cheapest, most efficient, and generally most satisfactory. Lifts and such like still require a satisfactory solution, but he believed motors would soon be on the market with 90 per cent. efficiency and a power factor of nearly unity. He hoped that sooner than later a condenser—at present commercially wanting—would be on the market. Whatever improvements are made in multiphase working, they will never be so good generally as low periodicity single-phase systems.

Mr. Esson regretted that the paper came so late in the session that it could not be properly discussed. He dealt with the question of tooling and former-wound coils, and regarded it as important to have motors which either required no repairs, or, if so, could be repaired with ease. After a few words on squirrel-cage rotors and their performance, he referred to condensers, and wanted to know if they were yet made commercially; the Stanley Company had catalogued condensers years ago.

Mr. Addenbrooke thought it unfortunate that the question of single-phase and three-phase should be raised again, and asked if there were not advantages in the multiphase systems which outweighed the mere provision of a suitable single-phase motor. That he considered the main point. Mr. Eustace Thomas objected to people classifying themselves as squirrel-cage or wound-rotor men: many firms were manufacturing both. He gave many useful statistical data of what is being done in America with motors, and figures of efficiency, speed regulation, &c.

Mr. Eborall, in his reply, told Mr. Field that the method of building rotors in his paper was intended for small motors, or say up to 30 H.P. He reminded Mr. Langdon Davies that station engineers are becoming more and more particular about starting currents, and replied to those who had criticised his terms that he detested the term self-induction, and always regarded it as being magnetic leakage. He put it forward that in single-phase motors very much better results can be obtained by forcing the flux density and large overload capacity can be obtained. The fundamental points were shape of teeth and flux density in them. He thought Mr. Rhodes indicated a very great advance. As to condensers one must have a mechanical apparatus: it can be as big as a house, and always liable to go wrong: liquid condensers were all right as motor starters, but little use otherwise. He concluded by giving an interesting geometrical construction for finding stator current and power factor, to which attention should be devoted when the *Journal* is issued. The close of the discussion marked the end of the session 1899-1900, which has certainly not been behind those of previous years in interest or choice of subjects.

Light Railways.—The Light Railways Commissioners have submitted to the Board of Trade for confirmation the Gateshead and District Light Railways Order.

BULSTRODE AND OTHERS v. SAX & CO.

No one can have read this case—a report of which appeared in the ELECTRICAL REVIEW for May 18th—without feeling that, although the verdict of the jury was undoubtedly a righteous one, the defendants to the action are nevertheless entitled to a certain amount of sympathy. The plaintiffs, who were employed in an older company, bearing the title now assumed by the defendants, published a circular to the customers of the old firm to the following effect:—"The firm of Julius Sax & Co. having gone into liquidation, we, the undersigned, being the heads of the various departments, have formed ourselves into a syndicate to carry on the business of electrical engineers and electric light contractors .... assisted by several of the late employés of the old company working on the lines of the old firm." In answer to this the defendants published the libel complained of, insinuating that the plaintiffs had been discharged from the old firm by them—and that they had been discharged for incompetence. The defendants admitted and endeavoured to justify this libel, but the jury awarded the plaintiffs £250 damages.

According to the summing up of the Lord Chief Justice, the plaintiffs had a perfect right to issue the circular which formed the red rag to the defendants. His Lordship also stated that the defendants overstepped the bounds of fair comment when they, in their turn, made the allegations for which they have had to pay the penalty—allegations which, as his Lordship pointed out, were untruthful and misleading.

The first impulse of anyone placed in the position of the defendants would be to take a pen and write swiftly what he thought, and we conceive that most men who act upon the impulse of the moment would have taken the second step of publishing abroad their opinions of such conduct. As the law stands at present it is an established principle that the good faith which exists between an employer and those in his employ renders it illegal, even in the absence of any stipulation to the contrary, for the persons employed to make use after the termination of the employment, of any materials or any information acquired by them while they were in that confidential relationship; and the Court will grant an injunction to restrain such use, in addition to awarding damages, and this in spite of the fact that the clerk or servant when employed entered into no covenant not to carry on business in opposition to his master. Upon this point the late Master of the Rolls said: "What the defendant is not entitled to do is to make an unfair use in the carrying on of such a rival business of information acquired by him while he was acting as clerk to the plaintiff." [See Louis *v.* Smellie (1895) 73 L.T., 226.]

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

11,282. "Improvements in electric check clock or alarm signal apparatus." H. Reich. Dated May 17th, 1898. A near and a distant electric bell are sounded with a variable interval between them. A wheel friction-tight on the hour-hand arbor can be turned by a ratchet-slide so as to set a hand upon the wheel to 12 on the dial. This wheel contains an inlaid ring bearing a lug which completes the circuit of the first bell by making contact with an over-lying finger. The circuit of the second bell is made when the finger is lifted into contact with a second finger, and the interval can be varied by the position given to a lever which is fulcrumed, and supports the upper finger by a pin. A graduated cam is used to set the lever. The alarm is set as follows:—The friction-tight wheel is turned till the alarm sounds, and the inlaid ring is then locked by lifting the lever sufficiently to make a hook which it carries enter a hole in the contact-lug. The wheel is turned again till the alarm-hand points to the time which is to elapse before the alarm is wanted. The lever is allowed to fall on the cam, and the wheel, now taking with it the inlaid ring, is turned a third time, until its hand is at 12 on the dial. 4 claims.

11,290. "Improvements in electric arc lamps." Messrs. P. R. Jackson and Co., Ltd., and L. C. H. Mensing. Dated May 17th, 1898. Relates to brake regulating-mechanism for arc lamps, described in Specification No. 20,902, A.D. 1896. A brake-pulley is controlled by a cord attached at one end to a screw on an angular regulating lever, and at the other to a lever pivoted to the regulating lever and to a radius link. The regulating lever carries a core below a shunt solenoid; when the core is raised, the levers are moved so that the cord allows the brake pulley to slip. A pin on the lever at the same time lifts a weighted lever which is pivoted to the lamp frame, and moves a latch; this engages a projection on the frame, and thus supports the weighted lever while the parts are in the feeding position. If the solenoid allows sufficient movement of the levers in the opposite direction, a pin on the regulating lever disengages the latch from the frame, and the weighted lever acts on the lever. The solenoid may move the parts until the lever makes contact with an insulated piece to cut out the lamp. 1 claim.

11,302. "Improvements in or connected with electrical switches." A. Brier. Dated May 18th, 1898. Relates to starting switches for motors in which the main switch is first closed and then the resistances cut out. On opening the

which they were interested, or had special knowledge, to

seemed to have taken some of the useful flux and allowed it to leak, thereby getting a leaking field out of step. He

main switch all the resistances are thrown into the circuit. The contact arms of the switch are connected by a connecting rod with the spindle of a worm which gears with a wheel of the resistance switch. On making contact, the worm and wheel are thrown into gear, and the arm can be moved by turning a handle. On opening the circuit, the rod pulls the worm out of gear, and the spring pulls back the arm. In a modified arrangement the rotary arm is replaced by a sliding bar controlled by a screw working in a half nut. 1 claim.

11,320. "Improvements in electrical ignition apparatus for gas burners." R. J. Urquhart. Dated May 18th, 1898. Lighting gas by electricity. By turning a plug of the gas cock, contact is made and broken between a part of the apparatus either attached to, or formed on the plug, and a sliding pin mounted in an insulated support. This contact completes the circuit of an electrical sparking or incandescent gas ignition apparatus of known construction contained in a casing surrounding the burner tube. According to the provisional specification, the casing may be made of two paper or other cups into which molten paraffin or its equivalent is run to insulate the electrical apparatus. 1 claim.

11,416. "Improved method of and apparatus for signalling or advertising by electricity." A. Ginisty and V. Metz. Dated May 19th, 1898. Relates to improvements on the apparatus described in Specification No. 1,017, A.D. 1898 for signalling or advertising by means of electric lamps. In the present invention, a circuit closer is provided for each sign to be shown. One terminal of each of the lamps on the signalling or advertising frame is connected to a contact, and the other terminals are connected respectively to corresponding contact strips, which, in conjunction with the contact plate on the armature of the electro-magnet, complete the circuit of all lamps on the frame necessary to form the sign represented by the corresponding circuit-closer. The magnet is electrically connected to the contact plate, and through the source of electricity to the return terminal of the frame. The terminal is in a shunt circuit, which does not include the lamps, and serves to close the circuit through the magnet. When the magnet is energised, it attracts its armature, so closing the circuits through the lamps and breaking the shunt circuit. Several forms of switch-board are described. In one a type-writer is employed, the keys of which complete the circuits through the corresponding electro-magnets by means of spring-controlled contact levers and contact springs, the type-writer serving also to record the signals. In another arrangement, a lever is adapted to depress on each operation, a number of contact making plugs, corresponding to the lamps to be illuminated. An interrupting switch is placed in the main circuit to break the circuit while the contact maker is being adjusted over the proper plug. Two or more frames of lamps may be connected in parallel to the same switching arrangement, or a number of frames, switchboards, &c., may be employed to exhibit a corresponding number of signs. 8 claims.

11,426. "Improvements in electrically propelled vehicles." Hon. R. T. D. Brougham and W. C. Bersey. Dated May 19th, 1898. Relates to vehicles having two independent wheels driven by separate electric motors. The object is to enable the inner wheel to cease driving when the vehicle is being turned. For this purpose a rotary switch is employed which in its central position supplies current to both motors, but when turned in one direction or the other cuts off the current from one or other of the motors. The switch is operated by projections, from the fore carriage acting on pins. A spring is provided for rapidly throwing over the switch towards one side or the other, whenever it is displaced from its central position. A spring and ball entering a recess in the switch plate are provided for normally holding the switch centrally. 4 claims.

11,498. "An improvement in holders for electric glow lamps." H. C. Gover and C. F. Procter. Dated May 20th, 1898. Relates to incandescent lampholders. An insulator has a reduced cylindrical part provided with longitudinal grooves to receive the plunger carriers, and side slots to receive binding-screws which project laterally from the carriers. A vulcanite or other insulating-ring is then placed on the cylindrical part, and a casing is attached to the insulator by screws or otherwise. 1 claim.

11,506. "Improvements in or connected with telephones.' J. E. O. Kumberg. Dated May 20th, 1898. Telephones, phonographs, telephone signals, recording. Telephones are arranged in conjunction with phonographs, so that while speaking into a mouthpiece, part of the sound is transmitted by a telephone transmitter, and part is conveyed by a tube to the phonograph at the transmitting station. The telephone receiver is mounted on a travelling arm of the phonograph so that messages may be recorded on the cylinder or received through an ear tube or through the electrically-connected telephone receiver. The phonograph is provided with an additional reproducer diaphragm connected by a tube to the telephonic transmitter for explaining "cause of absence &c.," to any calling subscriber in the absence of the called subscriber. This reproducer is placed in and out of action by a handle, and is provided with a cam traversing mechanism, the shaft also has an arm for raising the reproducer from the cylinder during the return or re-setting motion. The wire connecting the diaphragms passes through the screen and floating weight, upon which a double tool is pivoted. The floating weight is pivoted and is controlled by a spring and screw on one side and a stud on the other. Either tool can be brought into position by a slight angular rotation. The arm supporting the "micro-diaphragm" is mounted on a rod, and is provided with a driving screw. The arm is provided at its forward extremity with a saddle which runs on a bar. 15 claims.

11,519. "Improvements in electric brakes." H. P. Davis. Dated May 20th, 1898. (Date claimed under Patents, &c., Act, 1883, Sec. 103, October 22nd, 1897, being date of application in United States.) Relates to electrically-propelled vehicles, and especially to their electrically-operated brakes. The brakes are applied by electro-magnets supplied with current by the motors when they are cut off from the main and are running as generators. Each brake magnet is connected in series with one of the motors, and the brake magnets are connected in parallel, so that each motor supplies current in the proper direction to its own brake magnet, and if one brake sticks its corresponding armature fails to supply current, and the other motor supplies current in an opposite direction to demagnetize and release it. An automatic switch magnet throws the brake magnets in and out of circuit, when the power current is shut off or turned on respectively. 3 claims.

11,525. "Improvements in and connected with electrical switches." E. J. Wade and The Electric Motive Power Company, Limited. Dated May 20th, 1898. Switches for re-arranging the grouping of cells for motors, &c. The switches are fitted with contacts, so that, in changing from one combination to another, intermediate momentary arrangements are formed without breaking the main circuit or short-circuiting the accumulators. The arrangement described is one in which a switch is adapted to control 12 cells and group them (1) six parallels of two in each, (2) four parallels of three in each, (3) three parallels of four in each, or (4) two parallels of six in each. A drum is fitted with contacts connected in pairs. The cells 1 to 12 are connected to a series of fixed contacts. Between each of the desired positions 1, 2, 3, and 4, three intermediate combinations are formed. Resistances may be connected with the contacts so as to lessen local circuits whilst the switch is in the intermediate positions. 3 claims.

11,570. "Improvements in or connected with electrolytic cells." G. Bell and G. W. Bell. Dated May 23rd, 1898. Relates to apparatus, in which a mercury cathode is used, for decomposing alkaline chlorides to obtain a kaline hydrates and chlorine, and for similar purposes. Consists of a systematic method of removing the formed amalgam from the cell to another vessel, wherein it is decomposed by water to form an alkaline hydrate and mercury, and of returning the mercury to the cell. This alteration of flow is caused by alternately raising the head of liquor on the mercury in either the cell or the alkali vessels. The apparatus, in the form described, is constructed of three superposed tiers of vessels, two being the electrolytic vessels and a central one the alkali vessel. The electrolytic vessels receive a continuous supply of brine from an overhead tank by tubes and branch pipes having regulating valves. The upper alkaline vessel receives a supply of water, which then overflows by pipes to the lower vessels in succession. The gases liberated in the alkaline vessels escape by a main; those such as chlorine, liberated in the electrolytic vessels pass away through branches and a vertical main. The brine continuously flows away, during the electrolytic process, by branch pipes leading to a vertical main. The anodes pass through the walls of the vessels and stand just above the mercury. In each of the branch pipes connected to the main there is a valve, which is operated by a solenoid. When this valve is shut the head of liquid in the cells increases, and the amalgam formed, is thereby driven out through a connecting pipe arranged below the bottom level of each vessel and to the corresponding vessel. After being acted upon therein by the water for a time, the valve is again opened, and the head of liquid in the vessel decreasing, the mercury flows back. Each tube is provided with two standing gauge pipes, one connected to each vessel. As the head of liquid is raised in one tier of cells, it is lowered in the other, so that the mercury is continually but alternately flowing in at one side of the alkali vessel and out at other. This is brought about by the opposite solenoids being alternately operated by means of one switch having a revolving contact, half of which is of metal, and half of an insulator, and on which the brushes bear. Thus as the contact rotates, the valves on one side are turned off, and on the other side turned on. The variations in the head of liquid may be arranged in the alkali vessel instead of in the electrolytic vessel. 5 claims.

11,609. "An improvement in electrical fuses and cut-outs, chiefly applicable to the bridge fuse." A. W. Sowry. Dated May 23rd, 1898. Relates to an indicator for fuses. An indicating disc is connected by a wire or cord with the fuse, the wire passing through a perforation in the cover or handle. On the fuse blowing the disc drops. Other indicators may be employed, *e.g.*, the wire may be under tension, and on fusing may allow an ordinary bell indicator or the like to drop. 2 claims.

11,627. "Improvements in electric cables." W. S. Smith. Dated May 23rd, 1898. Conductors are formed of a central metallic core covered with one or more spirals of metallic tape. The tape employed is of the same metal as the core, a suitable adhesive being employed when necessary. 2 claims.

14,513. "A method of and apparatus for producing electrical spectacular effects." C. H. Cox. Dated July 1st, 1898. Spectacular effects are produced by means of high tension electrical discharges through tin foil or sheet metal pieces attached to a plate of ebonite, glass, or insulating material. A sheet or similar pieces of tin foil are fixed to the back of the plate, and the opposite sides are connected to the ends of the secondary circuit of a Ruhmkorf coil or the like. If desired, the metallic backing may be dispensed with and the ends of the secondary coil may be attached to the pieces at opposite ends of the plate. Arches, columns, and floral and other designs may be thus arranged and illuminated to the accompaniment of a crackling sound characteristic of such electric discharges. The performers may carry insulated plates or devices with metal pieces on the surface. The conducting wires pass through an ebonite or glass tube or handle and the controlling switch may be operated by the foot of the artiste or otherwise. Incandescent or arc lights may also be used. 4 claims.

14,548. "Improvements in electrical contact makers." E. W. Bowles. Dated July 1st, 1898. Relates to means for connecting electric light leads, especially for use in theatres. A box sunk in the floor or the like has an insulating base on which are mounted spring contacts fitted with terminals. The lid of the box is formed with grooves adapted to receive a removable frame carrying contacts to which are connected the leads led in through the handle. An inclined face is formed on the frame to ensure that the contacts slide into the proper position when the lid is closed. 4 claims.

14,566. "Improvements in electrical resistance devices." H. H. Lake. (Strassunder Bogen Lampenfabrik, Gesellschaft mit Beschrankter Haftung.) Dated July 1st, 1898. Two plates having radial grooved arms are connected together by a central bolt and distance pieces. An insulating strip, which may be notched, is placed in each pair of grooves, and a resistant wire is then wound helically in the notches. When these are filled, a second notched strip is placed in each groove, and the winding continued, and so on. The plates may be of other forms. Such resistances are suitable for use in arc lamps, and for other purposes. 2 claims.

14,599. "Improvements in anodes employed in connection with the electro-deposition of metals." F. Greenfield. Dated July 2nd, 1898. Anodes are formed of a series of rods, strips, bars, or the like. In one construction the suspension hook for taking over the current conducting rod has an upright strip which is connected to a current conducting cross bar or carrier bridge. This bar or tube is perforated with a number of holes, in each of which an anode rod, &c., is secured by means of a screw. The conducting bridge and suspension hook are coated with insulating varnish, enamel, or the like. The suspension hook may be swivelled to the carrier bridge. In modifications, the anode rods are arranged radially from a central conducting ring, fan-wise from a carrier bar, or rest horizontally on hooks on an insulated rectangular frame. 4 claims.

14,614. "Electric energy meters for alternating currents." F. Laarmann and H. Brockelt. Dated July 2nd, 1898. Energy meters for alternating currents. A spindle geared to a counter carries a conducting-disc situated in the fields of three separate electro-magnets placed equi-distant. One of these carries the main current; the second is connected across the mains, and is of high inductance relatively to its resistance; it also carries a secondary winding, supplying the third magnet, which retards the motion of the disc. In modifications the disc may be acted on by six magnets, or the second magnet may act on two opposite parts of the disc, and a part carry the secondary windings supplying the third magnet; or one limb of the second magnet may carry the secondary winding, and the part be without any. The third magnet may be replaced by a solenoid acting on a separate conducting drum attached to the spindle and containing iron. The magnets may be supplied with proportional main and shunt currents by the use of resistances or transformers. 3 claims.

14,726. "Improvements in primary batteries." W. Rowbotham. Dated July 4th, 1898. Relates to batteries of the kind described in Specification No. 2,378, A.D. 1897, and consists in arranging the cells together in series and in steps, and in connecting each cell with the one next beneath it by a siphon tube, so that the liquid flows through the battery, but the cells remain insulated from each other by reason of the bubbles of gas, formed during the action of the battery, which rise into the tubes and render the flow of liquid somewhat intermittent. 2 claims.

14,761. "Improvements in electrical safety fuses or 'cut-outs.'" W. E. Langdon. Dated July 5th, 1898. The fuse wire or strip is enclosed in a perforation in a refractory block, or in a groove between two blocks. In one form the fuse wire passes through a perforation in the block, being connected to terminals recessed in the block. The cover fits closely to exclude air. The provisional specification states that the block may be perforated for the escape of metallic vapours, &c. 2 claims.

14,809. "Improvements relating to electric accumulators or storage batteries and to the manufacture of plates or electrodes therefor." W. H. Smith and W. Willis. Dated July 5th 1898. Relates to plates or electrodes in which the active material is enclosed in perforated retaining-envelopes, and consists in making these envelopes in two parts, which preferably of celluloid, ebonite, or the like, with wide grooves on one side, and narrow grooves on the other, and the active material is placed in the wide grooves until it is flush with the surface, conducting-strips or rods are laid on the active material in one plate, and then the other plate also packed with active material, is placed on the former plate, and the two are pressed together. To facilitate these operations, the plates are placed on a hinged support, having projecting strips which enter the narrow grooves of the plates. In a modification, the second plate is replaced by a flat perforated plate. The plates are preferably used with the grooves vertical, the conducting-strips being attached to a conducting-bar extending along the top of the plate, and having a plate or bar of ebonite attached to their lower ends to keep the active material from falling out. The edges of the envelopes are held together by folded pieces of celluloid, ebonite, or the like, which are slid over their edges. The electrodes when in use are kept apart by perforated strips of material which fit into the narrow grooves, and the electrodes are held in place as a whole by elastic bands, retaining bars or plates being provided at each end of a group of electrodes, through which bars or plates, rods are passed, some extending above and others below the electrodes. 6 claims.

23,155. "Improvements in electric rail brakes and electro-magnets therefor." H. H. Leigh. (Gesellschaft zur Verwerthung.) Dated November 3rd, 1898. Relates to the magnet described in Specification 1,140, 1898. The reels and corresponding pole shoes are now made of separate pieces and built up. The magnet consists of a conductive core, conductive spools carrying wire coils on the core, the coils being wound and interconnected to form a multipolar electro-magnet with alternating positive and negative poles, brake shoes secured to the core between the flanges of the spools and partly surrounding the battery, and outer brake shoes secured to and partly surrounding the end spools of the electro-magnet and having segmental faces and anti-friction rollers. 2 claims.